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VITALIZING BIOLOGY TEACHING IN THE JUNIOR HIGH SCHOOL

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"Man needs not so much to be informed as to be reminded" says a philosopher. This is, perhaps, especially applicable to the teacher who has spent years in teaching of the same subject and has unwillingly permitted Time somewhat or entirely to dull the keen edge of enthusiasm which was so prominent an attribute of this teacher in the genesis of his teaching career. The teacher so frequently forgets that he is the only "fixed" star in the schoolroom around which ever new classes rotate to receive the light of information. The classes of to-day are as much entitled to receive this light without partial or total eclipse of the sparkle which eminates from teaching filtering through enthusiasm as the classes of fifteen, twenty, or twenty-five years ago.

Great teachers live on forever; great teachers vitalized their teaching; they gave with information a part of themselves. It was the vitalizing influence of the personal enthusiasm which made Sachs, David Starr Jordan, Linnaeus and others the great teachers they were, and it is this same vitalizing "by-product" which made certain men and women whom we have had as teachers stand out as a powerful influence in our life. It is to such teachers as these that we owe the love we have for a certain subject, for success in teaching is the product of knowledge multiplied by enthusiasm.

It will be impossible to prescribe in capsule form a quick remedy for anaemic teaching, for the teacher is the sum total of

his interest in the profession, his philosophy of life, physical well-being, and living habits in general, but we can at least re-erect some of the old markers which point the way to vitalized biology teaching. We are a favored group of teachers, for ours is a subject which itself is removed from static monotony. Each season makes it new, each hour of the day brings variations in form and functions; we are favored to open to every new generation in our time the greatest of all books, the Book of Nature, whose subject is Life.

The Teacher

The small democracy of the schoolroom should, no doubt, give first consideration to the leader in the democracy, the teacher. There have been great schools without fine furniture, modern equipment, expensive heating plants, yea, even without a building, because of great instructors; yet there has been no great school even though it had all the external ideal surroundings, which lacked an inspiring teacher. Let us, therefore, consider a few essentials which an enthusiastic teacher must include in his program.

We will mention first conventions. Of great importance to the teacher of biology are conventions. Here are brought together for a period of a few days each year the most outstanding people in the field, big men and women; men and women with wide experience and who have accomplished great things. Here one hears at first hand of important work being done by eminent workers, often before it appears in print. What an inspiration to sit at the feet of these progressive workers and learn! These speakers not only widen the horizon of the listeners but they fire them with enthusiasm and crystallize within them a determination to do and to know more, while personal contact with such leaders may profoundly influence for good the teacher's entire life. At conventions also are displayed the newest and most valuable aids in teaching, together with the latest literature on the subject. In short, conventions are both informational and inspirational.

Another important way to keep alive in one's subject is by wide reading in his field. What a wealth of material there is available! So much, in fact, that one must constantly keep choosing even from among the best. Such reading helps one to appreciate the magnitude and importance of his work. Furthermore, when a teacher knows his field of literature he is able to direct intelligently the reading of his pupils, thus making it

possible for *them* to contribute much of interest to the class work. This knowledge on the part of the teacher also gives the teacher an added prestige among pupils and parents alike, and is constantly a source of help in the teaching itself.

A teacher of biology should take many field trips not only in order to learn when and where certain material may be found but in order to fill his soul with his subject by contacting directly the supreme teacher, Nature herself. To the biologist as to no one else she speaks. No matter what his mood may be, she has a helpful message for him. Then, too, when teaching becomes dull and irksome, when little things worry and confuse one, a trip out in the open spaces so rejuvenates his weary soul that he can return to his classes a new man, again in command, and able to inspire others.

Another aid in keeping a teacher alive and interested in his field is a research problem. This type of work being different from teaching is at the same time restful, inspiring and enriching. Research calls for varied work along many lines which results in a vast collection of new, usable and interesting information, easily transferred to the class room. One can never be bored by time or place if one is interested in a research problem.

A fifth aid in vitalizing the teacher is a hobby. Every teacher of this subject should have at least one hobby in some field of biology and become an expert in that line, for it is clearly impossible for any one person to become an authority in every branch of so comprehensive a subject as this. Everyone admires a teacher who knows his field expertly. It also gives him a certain sureness of self. He can speak with authority and his opinion carries weight. This knowledge need not come from the study of books alone. It may come through making a collection of some sort, say of butterflies, moths, insects or plants, etc. The teacher must go out afield anyway in order to know what materials are available and when and where his classes may find them. If he takes with him a few boxes, envelopes or a net he is sure to bring back with him some interesting specimens that can be added to his one, or many, collections. Year by year his number of fine specimens grows, and year by year the collector's interest and knowledge grows. Finally he becomes an authority in the field he has been so interested in and it has come about in a most enjoyable way. There is also great pleasure and professional satisfaction in being an authority on such interesting groups of animal life as birds, fish, snakes and the like.

Last but not least we seek in a biology teacher enthusiasm. Enthusiasm is not a thing apart from the subject taught, nor a special "trimming" to the teaching technique. It is rather a state of mind through which the teaching filters. It grows from personal pleasures derived from the subject of the teaching field and a desire to share with others the joy which comes from this knowledge. It is a mental state formed by an experience like viewing one of the seven wonders of the world, and not the sticker placed on the windshield by a duty-impelled attendant at the hotel of one of the seven wonders of the world. It is a difficult matter to show how to acquire enthusiasm for it is a part of yourself; it is the value which you place upon the subject you teach.

The Class Room

Now let us leave the teacher and consider the class room. The class room should be made as attractive as possible. A beautiful board with an appropriate and lovely poem adds much to the desired atmosphere. Numerous books with abundant material should be available, books on all lines of biology, so that when a child has the urge to look up an article he may do so at once before the urge has gone. Collections of various kinds, well displayed, showing the proper ways to mount and preserve specimens are not only attractive but interest-provoking as well. These may be the personal property of the teacher, a class project, or individual collections. Collections are also invaluable as teaching aids whether they be of insects, grasses, flowers or what not.

An aquarium of some sort also adds much to the interest of the biology room. It need not be a large nor an expensive one. It can be made into any miniature habitat from a desert to a bog, with plant colonies growing in it, or it may be used for the study of water animals such as fish, frogs, snails, turtles and the like. Variety is always desirable and frequent changes in the aquarium and display work are eagerly looked-for and appreciated by the pupils.

Field Work

Since some may never have taken field trips with their classes perhaps a few suggestions here may be of value.

One should do as much of this type of work as time will possibly permit. A pupil will learn more on one field trip with a knowing teacher than he could learn in a month working alone,

or in many months if his study were wholly from books. On one field trip he can learn how to see, and where to look for certain things. He also sees things in their natural settings and associations and their appeal is certain. On such trips, too, a teacher has the best opportunity ever afforded him of really learning to know his pupils.

For best results, the number taken on a bird trip should be small, not exceeding six as a rule. However, in other kinds of work larger groups can be handled successfully. These trips can be taken after school, on Saturdays or on Sundays, going afoot when possible, otherwise using street cars, buses or automobiles for transportation. If birds are to be studied, early morning or towards sunset usually is the best time to be afield. It is then that birds are most active and most apt to be singing. After reaching the starting place, an hour or two at most is generally long enough to work; especially is this true if the trip is to be taken after school and at some distance. You will find the children are eager and tense the whole time and are never ready to stop work and start for home. This attitude towards their work is most desirable. Without fail, they will ask to go again, or they will want to try it alone, or in small groups without a teacher.

While bird sanctuaries and quiet woods along streams furnish the best places to study birds they can be studied to great advantage during the spring and fall, in any city park, on the way to and from school, and in one's own back yard. Keen eyes and patience are the only requirements, but field or opera glasses will add much to both enjoyment and success.

Collections

Just a word about collections and their value. Children are frequently inspired to start collections of various kinds through admiration for the teacher's well mounted, carefully labeled, and beautifully arranged specimens. This is the first step towards becoming a naturalist or scientist. Who knows where this hobby may lead? Encourage it! Frequently parents enter into the work of collecting also, and receive a liberal education along with their children. Furthermore, they thereby become pals with their children and an understanding develops between parent and child that is of utmost value to both. Again it is not at all uncommon for a discouraged failing pupil to take on a new interest in his other subjects because he has proven to himself through some outdoor collecting project that he can

master a thing or two. Once he has proven to himself that he is not a failure he may go on with his schooling and to a successful career. Many such once discouraged pupils have developed into well-known men and women, leaders in their chosen fields.

Activity Books

In order to add interest and make the work easier for both teacher and pupil, the use of an activity book is very desirable. Unfortunately only a few such books are as yet on the market. There are, however, two excellent books on Trees by Dr. Potzger of the Botany Department of Butler University that are especially helpful and fortunately low in price. He also has three books on Birds that are equally as good, and in the near future there is to be one on Insects. All of these are published by the Harter Publishing Company. These work-books stimulate great interest and are so arranged that the pupil can do practically all the work alone.

The hints given in this brief discussion are as old and common as the markers along the highway, both direct to your destination. The success of your trip, however, will depend on your driving.

COPPER ORE BODIES SEEN AS GIFTS FROM EARTH'S GREAT DEPTHS

Copper, key metal in both war and peace, is a gift of earth's great depths. Wherever copper ore bodies are found, they are associated with cracks, fissures or other types of major breaks in the earth's crust, states Charles Henry White, San Francisco geologist, in *Economic Geology*.

The copper-containing materials seem to have been squeezed up from the interior, more or less like toothpaste from a tube. Only since the material was at high temperature, chemical reactions took place with the rocks nearer the surface, so that the ore bodies are not the same minerals that started from the greater depths.

Assuming for the earth an originally fluid state, like that of the sun at present, Mr. White pictures a cooling earth as forming a number of concentric layers or zones, with lighter elements toward the outside and the heavier, less active ones at greater depths. The larger part of the earth's endowment of copper, as well as most other metals, would thus be concentrated far beneath the crust.

Despite this fact, however, the copper at or near the surface reaches impressive totals. The reserves of copper in known ore bodies are estimated at about 100,000,000 tons. Copper is present, in low concentrations, throughout practically all parts of the earth's crust; the outer crust is estimated to contain an average of 0.01% copper.

"If that be true," says Mr. White, "the first mile of depth contains 200 trillion tons of the metal, or two million times as much as is known in ore bodies."

ARCHIMEDES, A MATHEMATICAL GENIUS

A Play Developed as a Creative Activity in a Mathematics Class

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Undoubtedly a play which is the outgrowth of an immediate class situation will contribute more to the growth and enjoyment of pupils than one borrowed from an outside source. "Archimedes" is such a play. It was literally built by the pupils. Since no two situations are ever identical, this play, if attempted elsewhere, should probably be modified. It is given here to illustrate the creative efforts of pupils, to show the wealth of materials which are likely to be discovered, and to suggest the enjoyment which such an undertaking provides.

This play developed in an eighth grade mathematics class in which the members had become interested in "just-for-fun" problems or puzzles. On Friday of each week, some time was devoted to the solution of such problems. During the week pupils brought to class those puzzles which they had heard over the radio or had found in magazines and newspapers. Occasionally a few minutes were used to state the puzzle and to attempt solutions. Sometimes the problems were merely posted on the bulletin board. If, however, any member of the class did arrive at a solution, he merely stated the fact but did not reveal the answer until the end of the week. This gave all pupils an opportunity to have the satisfaction of solving many problems.

One day two boys dashed into the room and up to the teacher's desk well in advance of the remaining members of the class.

"This is a jim-dandy problem, Miss Reid," said one. "Bet it will stump you for a while."

"It's like this," continued the other, giving details.

By this time other pupils had arrived and the desk was surrounded. The teacher suggested that Jim explain his puzzle to the entire class; this he did. Soon little groups had formed at the blackboard, around desks, and at tables. There was much talking until all understood the puzzle thoroughly, and then there came a quiet period as each person studied it by himself. Suddenly the silence was broken.

"Eureka!" said the teacher.

"Eureka?" echoed several students.

"What?" said John. "That's a new word."

"It is a new word to you, perhaps," replied the teacher, "but it really is a very old word and one which every real mathematician knows. It means 'I've found it' or 'I've got it,' so when I found the solution to the puzzle which you gave me I said, 'Eureka!'"

"Where did the word come from?" asked Ann Muriel.

"It is a Greek word," continued Miss Reid, "and there is an amusing and interesting story about Archimedes connected with 'Eureka.' You can find it in one of the books on the history of mathematics in the library."

"I'll look it up and bring it to class tomorrow," said Robert.

"I'm Archimedes in the Pythagorean Society," said Robert's twin. "I'd like to find it."

"Suppose you work together and take the book home with you," the teacher answered. "You will find several interesting stories.

"Perhaps others may be interested in reading about Archimedes who was a great inventor. How many of you have used a slingshot? You should see the kinds Archimedes used. They were the forerunners of our modern cannons. Robert and Donald will have some fascinating stories to tell you tomorrow."

The two boys presented their report about Archimedes the following day. They related the life history of Archimedes, discussed his instruments of warfare, and explained the story of "Eureka." At the end of their talk they mentioned the Archimedean screw but said they did not understand just what it was or how it worked. John volunteered to look in another book to discover more about it.

By the time John made his report, other pupils had found time to do some reading and a lively discussion ensued. They could easily imagine that it was a difficult problem in that early day to get water to flow uphill. They became so interested in Archimedes and his achievements that sometime later when they had the opportunity to give an assembly program, they suggested a dramatization of some of the incidents in his life. After the suggestion had been approved by the school's assembly committee, they selected two incidents from the life of Archimedes which they thought could be effectively dramatized. To these they added a modern scene. Inasmuch as most of the pupils in this eighth grade class were members of the Pythag-

orean Society, the assembly was given as a joint project of the two organizations.

After the scenes were selected, the general idea of each was outlined, characters were listed, required properties noted, and necessary work inventoried. Pupils then decided how they would like to take part, both as actors and in the general preparation of the play. Every member of the group had the opportunity of participating in at least one manner, but more frequently in two or three different ways. Each chose those activities which were the most interesting to him. There was some guidance, of course, but in general, children were allowed to take the parts they wished, regardless of whether it was felt that the particular pupils were the ones best adapted to the roles they had chosen.

It was decided that each scene should have an announcer to give a synopsis of the action. The main facts were then to be elaborated and emphasized by the actors. Each character was expected to supply the lines fitting his part and contribute to the general development of the purposes and objectives of the scene.

It is interesting to note that none of the actors thought it odd that there never were any definite lines for the play. As they rehearsed in the auditorium, however, it became obvious to them that definite cue lines were necessary; consequently individual actors took the responsibility of seeing that the general conversation shifted to the next point which they wanted to make.

Another interesting process was the development of the announcers' talks. At first each announcer started merely by foretelling the action as he thought it should be told. However, they were constantly checked by other pupils because they either talked too long or omitted something necessary to the understanding of the scene which was to follow. As a result, the announcers wrote out their speeches, submitted them to an audience of the students in their particular scene and, with the actors' criticisms, elaborated or curtailed the material. The resulting introductory talks were then used almost verbatim by the announcers.

Meanwhile the play had become an all-school project. The English, speech, Latin, science, social science, home economics and fine arts departments caught the spirit of the undertaking and cooperated towards its success. Speech teachers were consulted by the announcers. Sand was placed in sacks which were

made in sewing classes and on which art pupils had painted the word "GOLD." Costumes, catapults and scenery were constructed or contributed by various departments. Pupils became detectives in a search for properties. Activity and enthusiasm were evident. Practically every division of the school helped in some way. The oft-regarded "exculsive" mathematics had proved itself to be one of the finest subjects with which to correlate human interests and activities.

With the preparations over and the play complete, an audience, already interested because of this widespread activity, came to a junior-senior assembly to see—

ARCHIMEDES, A MATHEMATICAL GENIUS

Introductory talk by the chairman: In our mathematics classes, we have come to regard Archimedes as an old friend. The story of his life is most interesting. Archimedes was unrivaled as a mathematician in the old world. He lived from 287 to 212 B.C. The son of an astronomer named Phidias, he was probably related to Hiero, one of the kings of Syracuse. He was educated at Alexandria, but as soon as he had finished his studies, he went to Sicily and remained there for the rest of his life. He invented the Archimedean screw, which was a tube, open at both ends, and bent into the form of a spiral-like cork-screw. When one end of the screw was immersed in water, and it was placed at an angle greater than the pitch of the screw and then turned around, the water would flow along the tube and out at the other end. We know of two great uses which the ancients had for the Archimedean screw, and probably there were others. They used it to remove water from the hold of a ship and also to drain the fields in Egypt after the Nile River had overflowed its banks.

Archimedes is also given the credit for overcoming the difficulty which the Greeks had in launching large ships. He used cogwheels worked by an endless screw. It is said that, after Archimedes had performed this seemingly impossible task, Hiero, the king of Syracuse, praised him. Archimedes replied, "If I but had a fixed fulcrum, I could move the Earth."

This man performed so many deeds previously believed to be impossible that Hiero at last proclaimed that, thenceforth the word of Archimedes was to be accepted on every subject.

Many stories about Archimedes help us to understand him and his personality. We shall dramatize some of them this morning.

Most of the scenes take place (*using pointer and map*) on the shore of the Mediterranean Sea, in the harbor of the City of Syracuse, on the island of Sicily, off the coast of Italy.

______________________________ will introduce Scene I.

Properties for announcer—Map of the Mediterranean Sea, pointer.

Act I

The Discovery of the Principle of Buoyancy

Scene 1. A King Ordering a Crown.

Time—About 225 B.C.
Place—Palace in the City of Syracuse.
Cast—Hiero, King of Syracuse.
Demeter, a famous goldsmith.
Courtiers.
Court Ladies.
A servant.

Announcer: Hiero, the King of Syracuse, decides that he would like a new gold crown. He calls Demeter, the best goldsmith of his time, and gives him the commission. Demeter says that it will require several sacks of gold. These the king orders to be carefully weighed, and the weight recorded. Demeter departs with the gold to make the crown.

Action: King Hiero may be seated on his throne with the court ladies and gentlemen grouped on either side forming a semi-circle. The conversation should lead to the king's crown and to the suggestion that he would like a new one.

Properties: Throne, cloth sacks of gold, old crown.

Scene 2. Demeter Returning With the Finished Crown.

Time—A few weeks later.
Place and cast—Same as Scene 1.

Announcer: Demeter returns with the finished crown. It is beautiful and the king admires it immensely. He thanks the goldsmith and rewards him with a sack of gold. The courtiers and ladies are admiring the crown, as the scene closes.

Action: Stage arrangement same as Scene 1. The servant may announce Demeter and effect a decided show of interest on the part of the court.

Properties—New crown, another sack of gold.

Scene 3. A Suspicious King.

Time—The next day.
Place—Same as Scene 1.
Cast—Archimedes.
Others same as Scene 1.

Announcer: King Hiero grows suspicious. He wonders if Demeter has not appropriated some of the gold for himself and made up the weight by putting in silver. The more he thinks about it the more it troubles him. He sends for Archimedes and asks his aid. Archimedes knows of no way to determine whether or not the king's suspicion is well-founded, but promises to try to discover the truth.

Action: King Hiero may be seated on his throne with his head in his hand and the crown on his knee. Thinking aloud, he may state the problem

and other facts such as that he has weighed the crown and found it to be exactly the same as the gold which he gave to Demeter. Suddenly, thinking about Archimedes, he may call a servant and send for him. Archimedes should show much interest in the matter. As the scene closes, he may be shown walking slowly up and down, meditating on the problem.

Scene 4. The Solution of the Problem, A Gift to the World.

Time—A few days later.
Place—The public baths.
Cast—Archimedes.

Announcer: Archimedes is still puzzled about the crown. He takes it everywhere with him. Here we see him at the public baths. He notices that his body is buoyed upward by a force which increases the more completely he is immersed in water. As he comprehends the principle of buoyancy, he suddenly jumps up and over the side of the bath, rushes out unclad and runs home through the streets of the city shouting, "Eureka! Eureka!" It is necessary to know that the Greek word, "Eureka," means "I've found it" or "I've got it." Don't forget that "Eureka" means "I've got it."

Action: A simple effect of a Roman bath can be obtained by using one-half of the width of a regular sheet of wrapping paper extending the full length of the stage and on which stones have been painted representing the outside wall of the bath. Archimedes may sit behind this and have the crown on a stool (also behind the wall) as if it were resting on the wall. Again he may think aloud and look at the crown, still puzzling about his problem. Then as he enjoys the bath he may say, "Queer how this water seems to push me up a little," etc. His last statement might be, as he looked at the crown, "If I could only apply this—." Then he should probably jump up and run off stage shouting, "Eureka!"

Properties: Wall of Roman bath, stool, new crown.

Act II

Scenes from the Second Punic War

Scene 1. Archimedes Successfully Defending Syracuse.

Time—215 B.C.
Place—Bay of the City of Syracuse.
Cast—Captain of the Syracusan Soldiers.
Soldiers of Syracuse.
Boys who control Roman boats.

Announcer: We have called the first scene "Archimedes Successfully Defending Syracuse." It takes place during the Second Punic War, when the Romans, led by Marcellus, were attacking the city of Syracuse. Archimedes devised all sorts of machines to combat this attack. He constructed catapults, which were military machines for throwing spears and other missiles, either short or long distances. This machine, in

principle like a modern boy's slingshot, was very effective in keeping off the Roman boats as they attacked. Our scene opens with the Romans attacking Syracuse. The time is 215 B.C.

Action: The following action is merely suggestive: In the foreground the soldiers of Syracuse lie asleep with only the captain by the fire examining his models of catapults, etc. As a background, a long sheet of wrapping paper, with waves painted thereon, stretches entirely across the stage, being held at either end by students who move it to make the motion of waves and a noise like the sound of waves. Cardboard boats are operated by students behind them, and as they advance, the Syracusan soldiers in the foreground awake, use their catapults, and shoot their ammunition. When struck, a boat sinks behind the waves. After a short battle the remaining boats withdraw, and the soldiers of Syracuse shout their victory.

Properties: Catapults, ammunition, swords, spears, wrapping paper waves, cardboard boats.

Scene 2. The Fall of Syracuse and the Death of Archimedes.

Time—212 B.C.
Place—City of Syracuse.
Cast—Marcellus.
Archimedes.
Roman soldiers—Controllers of Boats in Scene 1.
Syracusan soldiers—Same as Scene 1.

Announcer: The engines invented by Archimedes were so effective in repulsing the Romans that the attack turned into a blockade. For three years they beseiged the city. Finally, in 212 B.C., while the Syracusan soldiers made merry at an annual feast, the Romans took advantage of the laxity in the guard, surprised, conquered and pillaged the city. Marcellus, realizing the ability of Archimedes, gave strict orders that he should not be killed and promised to reward the soldier who brought the mathematician to him. Unfortunately, an impatient soldier, coming across Archimedes on the shore, commanded him to come with him. Archimedes was so absorbed in the figures which he had drawn in the sand in order to solve a problem, that he did not even notice the battle and at the soldier's command, cried, "Don't disturb my circles!" The infuriated soldier stabbed him. Marcellus was grieved and angry when he heard the news, for he realized that Archimedes was the greatest geometrician of his day. We shall see what becomes of the careless soldier.

Action: (Suggested only.) Marcellus and soldiers creep in from up stage right. Marcellus gives his command about Archimedes. The soldiers of Syracuse enter from up stage left. They are talking and laughing. When they see the Romans, they draw their swords and begin to fight. The Syracusans are slain. As the ferocity of the battle dies down, a Roman soldier approaches Archimedes, who has been sitting down stage left

drawing pictures in the sand. Their conversation ends in the death of Archimedes. Marcellus approaches and sees what has happened. He punishes the soldier severely.

ACT III

The Spirit of Archimedes

Time—Today.
Place—Living room of the Brown home in ________________.
Cast—Mr. Brown.
Mrs. Brown.
Jerry, their son.
Tom, his younger brother.
Alice, their sister.
Martha, her friend.
Tom's friends.

Announcer: In our last act we propose to bring the spirit of Archimedes up to date. Wouldn't Archimedes have a good time if he were living in this mechanical age?

Action: The front half of the stage may be set as a living room and the back half as a dining room. If the stage has a second curtain which parts in the center, it can be partially drawn, showing only the dining table and chairs. This arrangement gives a very good effect.

Mr. and Mrs. Brown are seated in the living room. Mrs. Brown is knitting, Mr. Brown reading the newspaper. Tom enters and teases his father for a dime to go to the movie. Mr. Brown tells him that he should budget his allowance more carefully. Jerry comes home from playing baseball, states that he has a hard geometry problem to do, and sits down at the dining room table. After that all is confusion in the home. Tom teases Jerry to help him with his boat. Alice and Martha arrive and at every chance turn up the radio until it fairly screeches. They get bread and sugar in the kitchen, and spill the sugar on the floor. Mrs. Brown sweeps it up with a "Eureka" vacuum cleaner. Tom's friends noisily burst in and persuade Mr. Brown to let him go to the movie. They attempt to get the girls' bread and a few friendly slaps are exchanged. Exasperated, Jerry says he cannot study and Mr. Brown tells him that he ought to be like Archimedes, who could study even while a battle was going on. Jerry says that there certainly has been a battle going on around there. The house quiets down and suddenly Jerry shouts "Eureka!" Mr. Brown is startled and says, "What's the matter? I thought you were the one who wanted it quiet." Jerry replies, "I've finally solved the problem!"

Although the play drew an enthusiastic response from the audience, it was the participating children who had the most fun and who undoubtedly received the greatest benefit in constructive growth. As a result of the undertaking, there was a noticeable quickening of interest in mathematics throughout the

remainder of the school year. There also was increased interest in other subjects as evidenced by numerous related activities. Of the various projects stemming from the play the most significant were investigations of the following: buoyancy, civil governments during the third century, B.C., the construction and history of a catapult, the densities of several metals, the Archimedean screw, the fulcrum, Roman boats, and early Roman costumes.

As has been suggested the play was, to an unusual degree, the creation of pupils. The main idea was theirs, they chose the scenes, they did the research work, they developed the lines, and they constructed the properties. Only the original stimulus, the one word "Eureka," was contributed by the teacher. In addition she provided guidance as needed. The adults, back stage at the completion of Act II, Scene 1, will not soon forget the joyful abandon with which pupils flung swords and armor into the air as the curtain fell. They were having so much fun that they were scarcely aware of the applause of the audience.

MAGNIFICENT ART GALLERY CREATED BY CAVEMEN OF 30,000 YEARS AGO DISCOVERED IN UNOCCUPIED FRANCE

Discovery in unoccupied France of a "magnificent" 30,000 year old gallery of prehistoric cave-man art, rich in pagan human figures, enormous bulls, horses and one black rhinoceros, is stirring scientific circles.

The world-famous authority, Abbe Henri Breuil, has succeeded in reporting to the British science journal, *Nature*, his authentication of the art discovery near the little town of Montignac in southwestern France.

Five schoolboys were the real discoverers of Lescaux cave, which will take its place in prehistoric annals alongside the "Sistine Chapel of Magdalenian art" in Altamira cave, in Spain. The new-found gallery of European art is pronounced far more ancient than the Altamira paintings, which are rated about 20,000 years old. Lescaux cave was decorated in closing days of the Aurignacian era of the Old Stone Age, a stage of culture which archaeologists have begun to distinguish by the still rather unfamiliar name of the Perigordian epoch.

Enormous bulls nearly 16 feet long, drawn in wide black lines with big spots sprinkled on the beasts' heads, impressed the Abbe Breuil, as he became first the expert critic to appraise the ancient masterpieces. In one area of the dark underground passages and galleries, he counted more than 80 pictures, chiefly done on blocks that have fallen from the vault above. Some ascending galleries of the cave are still almost entirely unexplored.

The artists who worked by torchlight in the cave painted horses with red color, giving them heavy coats in softly dappled pattern. Other animals portrayed, probably with magic rites as an aid in hunting, include oxen, bison, stags, two lions, and one questionable bear.

THE EFFICIENCY OF ELECTRICAL HEATING

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During the last several years the use of electricity for heating and cooking has received considerable impetus. A great variety of electrical devices, ranging from aquarium heaters to furnaces, is now to be found in the market. Some of this equipment is now built to a fairly high degree of perfection, but much room for improvement, from the standpoint of durability and economy, still remains in most of it.

The question of the economy of electrical heating as compared to other methods such as oil or gas heating is frequently raised, but obviously no general answer can be given because of the great variation in the prices of the commodities from one section of the country to another. It is possible, however, to determine the efficiencies of heating apparatus for various types and grades of fuels, and knowing these, it is a simple matter to determine relative economies for any set of fuel costs.

The work described below deals with the efficiency of electrical heating apparatus, but it is of a preliminary nature only, dealing chiefly with the methods of investigation, and is not intended to be a general index of the efficiency of electrical heating. The direct object of the investigation was a small inexpensive electric hot plate rated at 660 watts for use at 115 volts. Its heating element consisted of the usual coiled wire set in a grooved bed of porcelain. A light sheet iron box formed the base and support for the heating element.

The efficiency, as used herein, is defined as the total increase in heat energy in the material heated, divided by the total energy expended on the heater. This figure would depend to some extent on the kind of utensil used, and in order to obviate the difficulty it was decided to employ a sort of "ideal pan," consisting of a light sheet iron container, of such diameter as just to cover the heating element and of sufficient height to hold one liter.

The efficiency as defined above is not a true measure of the heating ability of the stove because it takes no account of heat lost from the container by radiation and evaporation. Provided that boiling does not take place, evaporation losses may be reduced to a negligible amount by floating a thin film of oil on the surface of the water filling the container. Hence, in order to

arrive at a corrected efficiency, it is necessary only to make allowance for radiation losses before dividing by energy expended.

The determination of radiation losses is most conveniently done by a graph on which rate of temperature change is plotted against temperature. For this purpose it is desirable to consider room temperature as a zero and reckon other temperatures accordingly. The construction of the curve itself is a simple matter. The container is filled to its proper level with water; the water is covered with its oil film; and all conditions are made as nearly as possible the same as those which will be encountered in future operations. Then after the water and container are heated to about 50 degrees above room temperature, they are placed on an insulated surface, and at one minute intervals the temperature is noted. The values thus obtained may be plotted to form the ordinary time-temperature curve shown in figure 1. Now if the mean temperature for each minute is subtracted from the mean for the preceding minute, one has all the necessary data for plotting the radiation curve shown in figure 2.[1] Unfortunately, however, owing to the limitations of ordinary laboratory equipment, these values usually will not give a very uniform curve. Much of the variation can be removed by computing a set of adjusted values. The adjusted mean temperature or adjusted temperature change for any one minute is found by taking the average of the data for that minute and the two adjoining minutes.

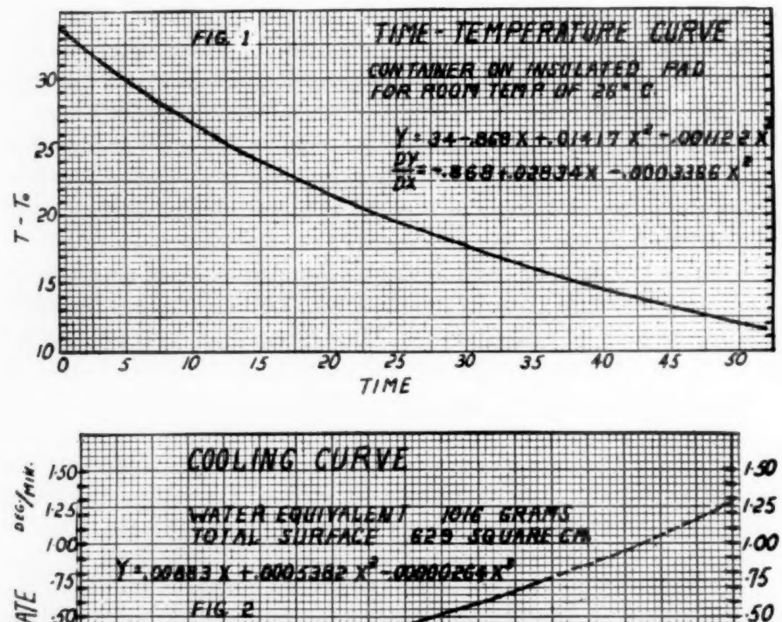
The curve in figure 1 may be satisfactorily represented by the equation

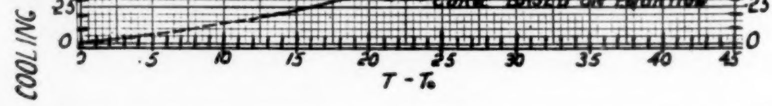
$$Y = 34 - .868X + .01417X^2 - .0001122X^3.$$

Differentiation of this curve gives rate of change of temperature with respect to time, which corresponds to the ordinate values in figure 2. By considering a number of points on curve 1, one could thus obtain sufficient data to plot curve 2. Although in the work done by the writer, the curve obtained from the original data and the one obtained by differentiating curve 1 did not coincide exactly, it can be seen from the figures given below that the agreement is not bad. It should be borne in mind in examining these values for dT/dt that the figures are given to hundredths, although original readings were made only to tenths.

[1] Edwin Edser, *Heat for Advanced Students*, London: Macmillan and Co., 1936, p. 132.

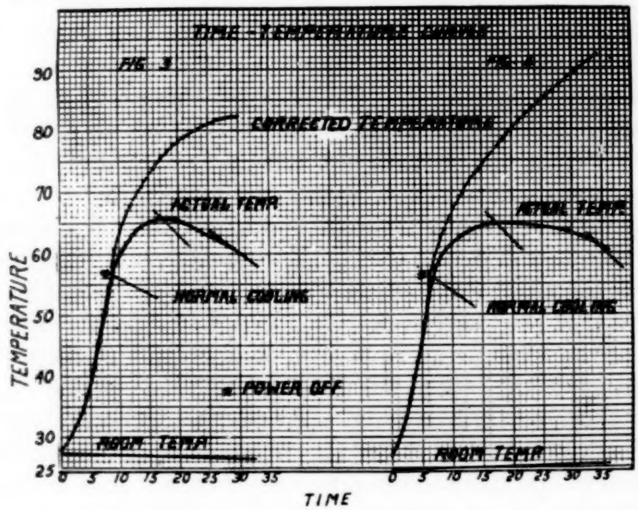
Time X (fig. 1)	0	2	19	26	35	50
$T-T_0$ Y (fig. 1)	34	32	22	19	16	12
$\frac{dT}{dt}$ by formula	.87	.81	.45	.36	.29	.29
$\frac{dT}{dt}$ from fig. 2	.85	.75	.42	.35	.25	.18





Having these preliminary curves drawn, one can proceed with construction of time-temperature curves characteristic of the particular equipment being tested. The data for these curves is secured in the same manner as that for the curve in figure 1, with the one difference that it is now necessary to make one minute readings of power supplied to the stove. The quantity

of water used in these runs should be exactly the same, and the total range in temperature, approximately the same, as they were during the construction of the radiation curve. The room temperature and the initial and final temperatures of the heated water need not be the same as they were in previous runs, since the curves are based on temperature difference rather than on actual temperature; and we may assume with negligible error that Newton's law of cooling holds, that is, that rate of cooling is strictly proportional to temperature difference.



The power, in watts, supplied to the heating apparatus is noted together with the temperature at the instant of starting each run, and at the end of each minute thereafter until the desired temperature is reached. The temperature readings are continued, after the power is shut off, until a definite falling tendency is noted. In the case of an electric stove or other apparatus having a rather high thermal capacity the power should be shut off some time before the desired maximum temperature is reached.

All of the data needed to compute the efficiency are now accumulated, but several other interesting details also remain to be brought out. The energy absorbed by the material heated is equal to the total rise in temperature multiplied successively by the water equivalent of the container and contents, and the mechanical equivalent of heat. The energy expended on the heater is found by determining the mean power for each minute,

taking the sum of these means over the entire heating period, and multiplying the sum by sixty, to obtain watt-seconds, or joules. The efficiency then is obtained by division, as explained in the definition given above. The entire computation may be shown by the equation

$$\text{Efficiency} = \frac{(T-T_0)(\text{W.E.})(4.186)}{(P_1+P_2+\cdots+P_n)(60)}.$$

Knowing the efficiency of the heater as it is ordinarily used, it is interesting to see what would be the effect if radiation of heat from the container could be prevented. To this end, a time-corrected temperature curve may be superposed on the original. It was for this purpose that the radiation curve was drawn. The method of correcting for radiation losses has been taken from Edser's "Heat for Advanced Students," with two improvements. Edser's curves were drawn by determining the rate of cooling for several minutes, plotting these values against actual temperature, and extrapolating the curve to room temperature. The curves used by the writer were drawn from actual readings over most of the usable range and were based on the difference between room temperature and the temperature of the water, a decided advantage when the tests extend over a period of days.

The data for drawing the corrected temperature curve is easily obtained from that used in drawing the original curve for the heater. The mean temperature for each minute having been figured, the amount of correction is obtained from figure 2. The total correction for any minute is, of course, the sum of corrections for that, and all previous minutes. Curve 3 shows the complete graph for a small electric hot plate.

Curve 4 shows a similar graph drawn for the same hot plate after it had been insulated by stuffing the box surrounding the heating element with "rock wool." The effect is quite noticeable in the time required for the temperature to reach its normal rate of fall. The short slanting lines intersecting the main curve represent the normal rate of cooling for the container and its contents. The fact that the actual curve deviates from this indicates that heat is still being supplied by the stove. As long as the slope of the actual curve is less than that of normal cooling the corrected temperature continues to rise. In the figure for curve 4, after thirty-five minutes the corrected temperature curve is still rising quite rapidly, although the same curve is nearly horizontal after thirty minutes in curve 3.

For run 1, illustrated by curve 3, an actual efficiency of 42% was obtained, and for run 2 (see curve 4) 53%, the increase of 11% being due to the insulation. If it is assumed that the maximum corrected temperature in figure 3 is 82°, a corrected efficiency of 63% is obtained. A similar efficiency for run 2 can not be obtained, since the test was not run long enough to show the peak in the corrected efficiency curve.

One other fact may be seen from a study of curves 3 and 4. The asterisks on these curves indicate the time and temperature at which power was shut off. In curve 3, a rise in temperature of nine degrees, or about 24% of the total increase takes place after no further current was being supplied. It is very plain from this that in the case of heating of short duration, such as might be represented by these tests, a considerable amount of energy is wasted by removing the pan from the stove before equilibrium is reached.

To summarize briefly, characteristic time-temperature curves, drawn for various types of electric heating apparatus, may be made to show such things as comparative curves corrected for radiation losses, and the effects of insulating or otherwise altering the apparatus. The method of drawing the corrected temperature curves is somewhat of an improvement on the method of Edser. Specific cases showed that radiation losses caused a drop in efficiency of one-third of the corrected value. It was found also that surrounding the heating element with "rock wool" increased the uncorrected efficiency by 11%. Finally, in order to obtain best results with a heating apparatus having a considerable thermal capacity, the material being heated should not be removed until equilibrium is reached.

REMOVING GLASS STOPPERS

M. Gordon Duvall, *Cincinnati, Ohio*

Since frozen glass stoppers are constant problems to all science teachers and laboratory workers, may I pass on the results of my experience for what they may be worth.

After many trials I have found the following procedure to be most effective:

1. Cleanse the neck and stopper of the bottle either by soaking, or wiping with a dry cloth, if you prefer.
2. Cover the stopper head with some four layers of toweling.
3. Grasp the protected stopper head firmly with pliers and twist.

I hope this may prove helpful to others in this very annoying situation.

TRAPPING AND REARING COCKROACHES FOR LABORATORY USE

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Despite their rather unattractive personalities cockroaches have certain qualifications which make them excellent living laboratory subjects (as long as they are adequately caged) both for the research worker and the biology instructor.

Their large size, omnivorous food habits, rapid growth and reproduction, and hardiness make cockroaches easy to rear and experiment on in the laboratory. Furthermore, they are readily obtainable in almost every locality and during almost any season of the year. While these factors are important to research entomologists, especially those working in the field of insect physiology, they are even more important to the biology instructor who wishes to provide living insects for experiments, projects, demonstrations or exhibits but cannot devote an excessive amount of time to their care.

The present review of some of the methods which have been devised for trapping and rearing cockroaches has been designed primarily for those biology teachers who may wish to tap this large but little used reservoir of living material for laboratory use. It should prove especially useful to teachers who include student projects in their courses. All the traps and rearing cages described could easily be constructed by the average high school student, and the trapping and rearing of the insects is so simple as to be almost foolproof. While the devices described have been designed especially for cockroaches, they may be adapted for use with other species of a similar nature.

Before entering into this main phase of the paper it may be well to consider briefly some of the more important species of cockroaches, their habits and life cycles, and some of the control methods in use.

THE DOMESTIC SPECIES OF COCKROACHES

Cockroaches belong to the family Blattidae of the order Orthoptera. There are about a thousand species, but fortunately less than forty-five of them are to be found in North America, exclusive of Mexico (Comstock, 1924). Most of these species live in the woods and fields, only four species being commonly

domestic, except in the south. Perhaps the most common is the Croton Bug or German cockroach (*Blatella germanica*), which is a native of Europe. It is $\frac{5}{8}$ of an inch long and light brown in color, with two dark brown lines on the thorax. It is the smallest and most persistent of the four species, and reproduces fastest because it lays more eggs and has a shorter life cycle.

Perhaps the second most common species is *Periplaneta americana*, the American cockroach. In the middle and western states and in Texas it is often the most abundant species. It is the largest of the domestic species which are common, measuring an inch and a half in length. It has long, well-developed wings. It is especially bad as a pest in ships, and frequently injures books by eating the starch from the bindings. A native of the southern states, it is the only one of the four species which is endemic. This adds an interesting footnote to the fact that the majority of our pests, both plant and animal, are alien species.

The Oriental cockroach, *Blatella orientalis*, resembles the German cockroach but is somewhat larger (one inch long), stouter, and darker. It may even be almost black, whence has come the rather misleading name of black beetle. The male has short wings, and the wings of the female are mere rudiments. It is a native of the Orient, arriving here via Europe, and is most common in the East and South.

The least abundant of the four is the Australian cockroach, *Periplaneta australasiae*. As the name implies, it is a native of Australia and it arrived in this country relatively recently. It is most common in the South. Similar to the American species, it can easily be distinguished from it because it is somewhat smaller and darker and has prominent bright yellow markings on the thorax and the front of each wing.

Habits

Cockroaches thrive best in a warm, moist environment. They are especially abundant in kitchens, pantries and bakeries where food is available in addition to moisture and warmth, but are liable to be found any place where this combination of factors exists. During the day and while lights are on they hide in cracks and crevices and under furniture, coming out only when it is dark. Their flat bodies enable them to hide in narrow crevices and to go through unbelievably small cracks, and their dark color may be protective. They are omnivorous in their food habits, consuming practically anything which is edible, even

members of their own species! Herbert Smith (Herrick, 1936) reports that in Brazil cockroaches eat the eyelashes of children while they are asleep, and that they also eat fingernails and toe nails! Cockroaches have also been known to ruin considerable numbers of books. However, they doubtless prefer the food to be found around a well stocked pantry or kitchen.

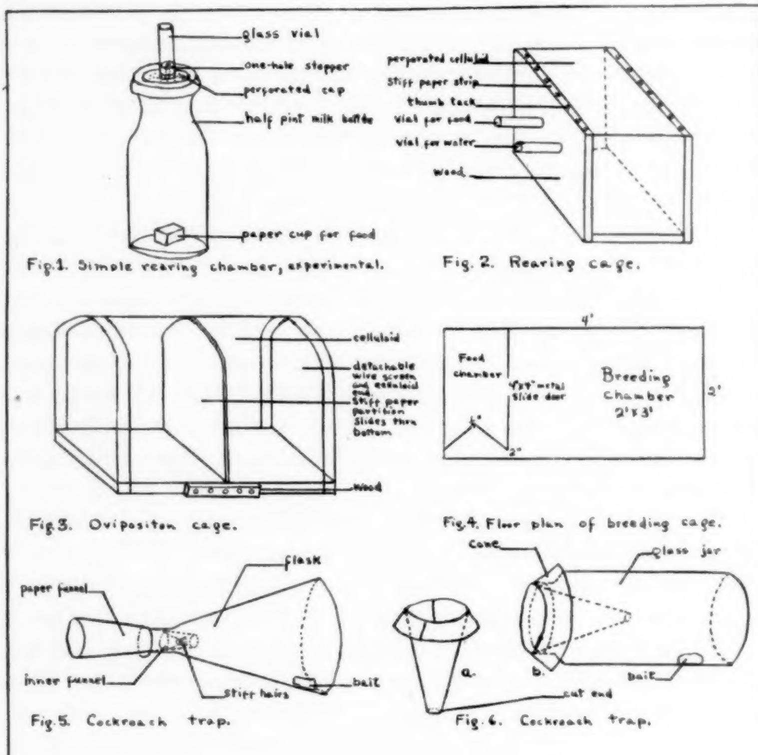

PLATE I. Equipment used in studying cockroaches. Fig. 1. Experimental chamber for one or a few insects. Fig. 2. Cage for rearing large numbers of cockroaches. Fig. 3. Cockroach oviposition cage with celluloid sides, detachable wire screen and celluloid ends, and removable central partition. Rearing and oviposition cages designed by M. C. Swingle, U.S.D.A., Tacoma Park, Md. Fig. 4. Floor plan of breeding cage. Designed by A. G. Grady, 1928. *J.E.E.* 21: 609. Fig. 5. Cockroach trap with stiff hairs on inner end of cone to prevent escape. S. A. Graham. See F. L. Washburn, *J.E.E.* 6: 327, 1913. Fig. 6. Cockroach trap. J. P. Barrett, O.S.U. Fig. 1 from C. M. McCay and R. M. Melampy, *Care and rearing of* Blatella germanica, p. 283, *Culture Methods for Invertebrate Animals* by J. G. Needham et al. Other figures from Alvah Peterson, *A Manual of Entomological Equipment and Methods*, Ann Arbor: Edwards Brothers, 1934. (Part I.)

In several respects cockroaches may be of some value. They are scavengers and may thus remove objectionable plant and animal remains, and they are enemies of bedbugs. These things, however, hardly balance the damage they do by destroying and contaminating food, destroying books, disseminating their disagreeable cockroachy odor, possibly carrying diseases, and making general nuisances of themselves.

Cockroaches are great hitch-hikers, and have been disseminated widely from city to city in shipments of grain, groceries and other foodstuffs. They may be carried home from the grocery store with the groceries, and from house to house in furniture and supplies. All the domestic species except the American have been brought to this country by ships. They also travel along water pipes. This is especially true of the Croton bug, which got this name because it became very abundant in New York after the construction of the Croton aqueducts and is intimately associated with that system. Cockroaches may even have regular migrations. Howard (1895) reports a migration from one building to another in Washington which was composed of thousands of insects marching in a solid stream for two or three hours. They were swept back and scooped up by the shovelsfull, but were deterred only by a barrier of hot ashes. They then went down the street to another building! There was no evident reason for leaving their old home.

Life Cycle

Being Orthoptera, cockroaches are heterometabolous and therefore have only the egg, nymph and adult stages. The eggs of the cockroach are unusual in that they are produced in bean-shaped capsules called oötheca, which occupy most of the abdomen of the female before being deposited. The oötheca are divided into chambers by a longitudinal partition and a number of transverse partitions. Each chamber contains a single egg. The oötheca of *Blatella orientalis* contain sixteen eggs and those of *B. germanica* forty to forty-two in most cases. The female may go around for some time with an oöthecum partially projecting from her abdomen. When first deposited the oötheca are creamy white, but they soon turn the same dark color as the insects. Hummel (in Herrick, 1936) reports that the mother may sometimes tear open the egg case when the young are ready to emerge. Seiss (1896) reports that *B. orientalis* females under his observation deposited an average of eight oötheca each during their reproductive life of twenty-one weeks.

The nymphs are whitish just after emerging from the egg or moulting, but soon turn brown. In general they resemble the adults except that their wings are quite small or even rudimentary. The number of instars seems to be somewhat in doubt, but according to Hummel (in Herrick, 1936) *B. germanica* under his observation moulted six times, taking three to five months. In their habits the nymphs resemble the adults.

The time required for a life cycle appears to be rather imperfectly known, and it has been stated that it is four or five years in some species. In the species which have been studied it is much less, though unfavorable conditions might extend the observed times. Marlatt (1915) says cockroaches (*P. americana*) hatched July 11 reached maturity by March 14 to June 12 the following year, thus making the total life cycle somewhat less than a year. Haber (1919) reports a life cycle of 142–153 days for *B. germanica* divided as follows: egg 39 days; nymph 82 days; age of adult at mating, 16–28 days; time from mating to egg laying, 4 days.

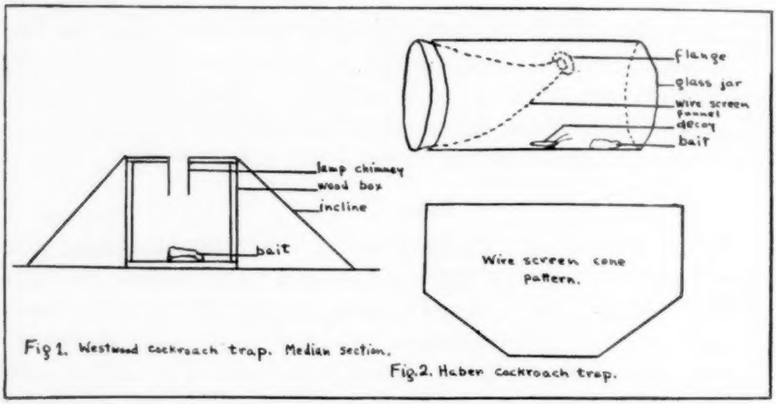

PLATE II. FIG. 1. Westwood cockroach trap, described by Herrick (1936). Fig. 2. Haber cockroach trap, described by Peterson (1937).

CONTROL METHODS

Cockroaches are difficult to control because they hide in crevices and are wary and shy of baits and traps, as well as because of their large numbers, rapid reproduction, hardiness, and rapid migration. To be successful one must be persistent and thorough and must use large amounts of poisons. Often combinations of several methods are necessary. The control devices are largely of three types: fumigants, poison, and traps.

In addition, cleanliness, the sealing up of all possible hiding places and entrances, and the storing of all food in tight containers are of considerable help.

Hydrogen cyanide gas provides the most effective form of fumigation, but is dangerous and difficult, because there are usually many cracks where roaches are abundant. Carbon bisulphide is effective, but dangerous due to its explosive tendencies. Burning pyrethrum cones (made by moulding the moistened powder and then drying in an oven) is the safest method of fumigation and is quite effective.

Sodium fluoride is by far the best poison, but is poisonous to humans also and so it should not be used when small children are around and should not be gotten into food or dishes. Powdered borax is quite effective and is perfectly safe to use, as it is not poisonous to humans. Either of these poisons may be made more effective by mixing with sugar or flour. Phosphorus paste has also been used but is poisonous to humans and has little to recommend it over sodium fluoride or borax. An ingenious old time method is to mix plaster of paris and flour dry. When the cockroaches eat this mixture it solidifies in their digestive tract and kills them. It is really not a poison and is harmless to humans, so it makes a good control agent if only the cockroaches will eat it! Perhaps the most interesting method of cockroach control is a biological one described by Sweetman (1936). He states that one or two toads kept in the kitchen will quickly reduce or even eradicate the cockroaches. Water should be supplied for the toads. For squeamish housewives who would hardly prefer toads to cockroaches he suggests placing the toads in cages which contain bait to attract the cockroaches.

Methods of Trapping Cockroaches

With these basic facts about cockroaches in mind, we may now turn to a consideration of methods of trapping and rearing these insects. The various methods of trapping cockroaches to be described have been designed primarily for securing research specimens, but they would serve equally well for cockroach control.

Perhaps the simplest type of trap consists merely of a large glass jar or large tin can which is bright and smooth inside. Bait is placed on the bottom and cardboard ramps provide a means for the cockroaches to reach the top of the container from the floor. Once inside the can, the cockroaches are unable to scale

the smooth walls, and are thus trapped. As an added safeguard it might be well to place a thin film of vaseline or other grease around the inner edge of the can. Herrick (1936) describes a somewhat more complicated variation of this type of trap devised by Westwood. The can is replaced by a tight wooden box with a round hole just large enough to accommodate a straight lamp chimney cut in the top. The cockroaches enter this hole and are prevented from leaving by the chimney. (Plate II.)

The second general type of trap consists of a wide-mouth jar or a flask with a cone placed in the opening. The cockroaches enter through the wide end of the cone, but are unable to find their way out through the small end. Peterson (1934, 1937) describes three traps of this type. Perhaps the simplest of them was designed by Barrett of Ohio State University. It consists merely of a wide-mouth glass jar and a filter paper cone. (Plate I, Fig. 6.) The trap credited by Washburn to Graham (Plate I, Fig. 5) makes use of a flask and two paper cones, which are held in place with vaseline. A small cone fits inside a larger one. The small end of both cones has a diameter of $\frac{3}{8}$ inch, the end of the smaller cone being fitted with short, stiff human hairs. Washburn reports that the hairs are an unnecessary complication if the trap is kept in a dark room, but that in the light the insects try hard to escape and may do so if the hairs are not present. The most difficult of the three traps to construct was devised by Haber (1926) and utilizes a wire screen funnel with a flange at the small end. This is placed in a glass jar. (Plate II, Fig. 2.) This trap is doubtless more sturdy than the other two and perhaps more effective.

Any type of food, especially if it has a distinct odor, may be used in these traps. However, Washburn (1913) reports that banana was far superior to any of the other baits he tried.

Methods of Rearing Cockroaches

Because of their omnivorous food habits, hardiness and resistance to diseases and parasites, cockroaches are not as difficult to rear in the laboratory as many other insects. However, it is important that they be kept in a fairly dark place with a temperature of around 70°F. and a high relative humidity. There should be a supply of water as well as of food. Haber (1926) states that cockroaches are on the average composed of 70.24% water, and Gunn (1931) reports that at 30°C. they lose daily an amount of water equal to about 9% of their original

body weight. With this reduction in the hydration of the body the cockroaches go toward a lower temperature where the relative humidity is higher. These facts indicate the importance of an adequate water supply and a high relative humidity.

Rearing cages may be divided into three classes: those for stock cultures, experimental cages, and breeding cages. Various types of each will be considered, all of them being described in either Peterson (1934, 1937) or Needham (1937). Unless otherwise noted the cages are designed for *Blatella germanica*, which is the most common laboratory form. However, they could easily be adapted for other species.

Cages for stock cultures vary from simple cans or jars to rather complicated devices. Dobrovolny (1934) as reported by Peterson (1937) merely used open fruit jars and one gallon tin cans and kept specimens for a year with low mortality. He coated the walls with a thin layer of stale butter to aid in preventing escape of the insects. Kelley (in Needham 1937) recommends wide-mouth glass jars with a layer of sawdust and a small pan of water in the bottom. He uses a thin layer of vaseline around the rim and cheese cloth held over the top by a rubber band to prevent escape. McCay and Melampy in the same volume suggest a museum jar or fish aquarium covered with cheese cloth. They use a chick waterer to supply water to the cockroaches, with absorbent cotton in the pan to prevent drowning.

A slightly more complicated cage of this same general type was used by Haber (Peterson, 1937). He stoppered a wide-mouth bottle with a perforated cork, the lower end of the cork being covered with a fine meshed brass screen. A bit of dampened sponge was placed in the perforation to maintain a high humidity. A piece of cardboard just wide enough to pass easily through the mouth of the bottle and slightly longer than the inside of the bottle was inserted into it with the free ends down. As the cardboard straightened out it formed a shelter under which the specimens spent much of their time.

A second general type of rearing cage includes wooden boxes or trays. A fairly simple form of this is the cage devised by Swingle (Peterson, 1934), which is constructed of wood and perforated celluloid with two glass vials inserted in one side for the provision of food and water. (Plate I, Fig. 2.) In the entomology laboratories at Ohio State University large open-topped trays are used. These are about six inches high and three

feet square. Around the edge a four inch strip of celluloid is fastened securely to prevent escape. The joints are caulked for the same reason. The advantage of this type of cage is that the insects can be worked with easily, but it could not be used with flying species. Furthermore, the entire room would have to be controlled for the proper humidity.

The most elaborate of the stock culture cages was designed by Yeager (Needham, 1937). It is designed primarily for *Periplaneta americana* and consists of a wooden framework on legs. The bottom is of pressed board, the sides of glass below and copper wire above, and the top of pressed board hinged at one side. The legs are set in cups of water to keep out ants. A covered hole in the bottom with a metal shaft leading down serves for the removal of numbers of the cockroaches. They are swept down this shaft into a beaker edged with vaseline. The glass portion of the cage is also rimmed with vaseline at its upper edge. Oötheca may be removed to other containers for hatching.

A very satisfactory breeding cage has been designed by Grady (1928; Peterson, 1934). It consists of a tight, screened box 2 by 2 by 4 feet in size. It is divided into a 2 by 3 foot breeding chamber and a one by 2 foot food chamber. (Plate I, Fig. 4.) The breeding chamber is filled with loosely piled lath, and these are wet to maintain a high relative humidity. There is a door one foot square on top of the feed box with a felt strip to serve as an insect-tight gasket. Roaches are removed through this door when needed. Since cockroaches can escape through the smallest crevices all joints are caulked. The cage rests on bricks above water and kerosene in a large galvanized tray 3 by 5 feet, by 6 inches deep. There are two passages between the food and breeding chambers. One is by way of a two inch opening into a V-shaped chamber which has a quarter inch opening leading into the food chamber at the point of the V. The cockroaches are able to enter the food chamber this way but it is hard for them to find their way out. The other opening is four inches square, but may be closed by a metal slide. It is thus possible to concentrate the insects in the food chamber if desired by closing the larger opening.

An oviposition cage devised by Swingle (Peterson, 1934) is made of celluloid with detachable wire screen and celluloid ends, and is featured by a cardboard partition which slides up through the bottom and permits the segregation of males and females or any other two classes of cockroaches.

Turning now to experimental cages, it should be noted that any of the above cages may be used for certain types of experiments. In some cases, however, one may wish to segregate one or a few insects for experimental purposes. McCay and Melampy describe a simple rearing chamber which serves this purpose very well. (Needham, 1937.) It consists of a half-pint milk bottle. The cap is perforated to admit air and a somewhat larger hole is made to accommodate a piece of glass tubing. A vial filled with cotton is attached to the tubing by means of a one-hole stopper, and the free end of the tubing projects into the bottle. The cotton is kept moist, thus maintaining a high relative humidity in the bottle. The food may be placed in a small paper cup. For *Periplaneta spp.* a larger size milk bottle would probably be more suitable. Pint-sized, cylindrical, waxed cardboard containers with tight lids may be similarly used.

The methods of maintaining a high relative humidity in the above cages are all relatively crude and do not permit holding it at any definite per cent. If this is desired for experimental purposes vessels containing saturated solutions of various salts may be placed in any of the closed cages. Sodium or potassium chloride would perhaps be most suitable for ordinary rearing of cockroaches. The relative humidities which may be maintained by using various salts are as follows:

Calcium chloride	35
Calcium nitrate	55
Ammonium nitrate	63
Sodium chloride	75
Potassium chloride	85
Potassium nitrate	93

There is one final consideration in rearing cockroaches: the food supply. Because of their omnivorous feeding habits this is not as important as it is in the case of many insects. However, various investigators have found certain foods superior to others.

Dobrovolny (1934) took the easiest way out and fed his cockroaches table scraps with good results. Grady (1928) fed his sweetened bread and milk weekly, with 100 gm. of yeast added occasionally. Kelley (Needham, 1937) used a mixture of bread, corn starch, lettuce and water, but found that they also liked sour milk and library paste. McCay and Melampy (Needham, 1937) recommend a somewhat more carefully compounded diet:

ground whole wheat, 50%; dried skim milk, 45%, dried yeast, 5%. The ultimate refinement is, however, achieved by Zabenski (Uvarov in Peterson, 1937) who carefully formulated the following artificial food especially for cockroaches: 18 parts ovalbumine, 56 parts starch, 20 parts saccharose, 2.3 parts agar, 3.7 parts McCollum and Simmonds' salt mixture, and vitamins A, B, C, D, E and G.

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ALLIGATORS NEED PROTECTION

Even alligators are in need of protection from over-shooting, the U. S. Fish and Wildlife Service states. The big bull 'gators, 12 to 15 feet long, that used to yield hides for large-sized suitcases and other leather goods, are practically never seen any more, even in the deepest recesses of the South's greatest swamps. Old-time swampmen say there are plenty of five- and six-foot sizes, but no really huge ones. However, where the reptiles have received protection, they are already starting a comeback, and it is hoped that eventually selective hunting will afford the resident hunting population a steady income source.

A LECTURE DEMONSTRATION ON OIL FILMS

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Students in science have observed the effects when small quantities of oils of various kinds have been dropped upon the surface of water. They have noticed that some oils form flattened globules or lenses while others spread out upon the surface and the more inquisitive students have sought an explanation. Such interest should be encouraged for it affords the teacher of chemistry a fine opportunity to apply the scientific method in the attack upon the solution of the problem and affords opportunity as well for the discussion of surface tension from a somewhat different point of view. Other important implications follow and the student may be encouraged to consider not only the structure of molecules but to actually apply his knowledge of mathematics to determine the length and cross-sectional area of molecules. Certainly the phenomena are of utmost importance in studying adsorption and what happens in boundary layers to increase or decrease the tension on a liquid surface. They have a direct bearing also upon the colloidal state and help to build up an understanding as to why given submicroscopic particles carry electrical charges of like sign and hence are stable. To students of biological sciences a valuable insight is given which should serve to account for various phenomena in organisms often difficult to explain.

THEORETICAL CONSIDERATIONS

Scientists generally agree that the orientation of molecules in a liquid surface is due to the influence of electric stray fields, the magnitude of which may be measured by determining the dipole moments of the unsymmetrical molecules. Certain long organic molecules possessing these polar active groups form films when dropped upon the surface of water. Langmuir,[1] further substantiating the evidence of Lord Rayleigh,[2] has given considerable evidence that these films are monomolecular layers and as such he has given a laboratory method which may be adapted for measuring the thickness of an oil film corresponding to the length of the molecule and also the cross-sectional area from a knowledge of the density of the compound and Avoga-

[1] Langmuir, *J. Am. Chem. Soc.*, 39: 1848–1906 (1917).
[2] Lord Rayleigh, *Phil. Mag.*, 48: 331–5 (1899).

dro's number. This spreading of films on surfaces is determined not only by the shapes of molecules but by the relative activities of different portions of the molecules. Molecules as stearic, palmitic and oleic acids, each containing a long hydrocarbon chain and a carboxyl group are packed together on the surface of water, their inactive portions standing at right angles to the surface, with the active carboxyl groups being attracted and directed into the main body of water. Other polar active groups besides $-COOH$ are $-OH$, $=O$, $-NH_2$, and $-SH$. Harkins[3] infers that the free energy of these polar groups is a minimum when their electric stray fields occur in the presence of water, which also has a pronounced polar character, since mutual compensation takes place.

Addition of a spreading oil to the surface decreases the surface tension of water but slightly up to a definite amount of added substance. Beyond this limit further addition causes a great decrease in tension. Langmuir has shown that the saturated fatty acids cover approximately equal areas per molecule irrespective of the length of the carbon chain. The same may be said, also, of their glycerides. Esters of two chains (as amyl stearate) support the idea that part of one of the chains lies in the surface in contact with water. In the case of lower members of the fatty acid series, the molecules lie flat on the surface. Unsaturated fatty acids, as oleic acid, cover greater areas per molecule, the double bond being attracted to the water surface, since unsaturated hydrocarbons are generally more soluble than the corresponding saturated hydrocarbons.

Adam,[4] using the same type of apparatus, arrived at practically the same conclusions. He suggested that molecules are oriented at the surface by fitting together the different shapes.

Laboratory Procedure

A wooden trough, 2 m. long, 20–25 cm. wide and 4–6 cm. deep, lined with copper, is used. The trough is scrubbed with a cleansing powder, then washed thoroughly with soap and finally rinsed well with fresh tap water to rid the inside surface of all oily matter. The trough is then filled with fresh tap water to a depth of 1–2 cm. After the pool comes to rest a thin layer of lycopodium powder or starch is sprinkled over the surface at one end. A satisfactory powder duster may be made by covering

[3] Harkins, *J. Am. Chem. Soc.*, 17: 354–64; 17: 541–96 (1917).
[4] Adam, *J. Phys. Chem.*, 29: 87–101 (1925).

a small wide-mouth bottle containing the powder with several thicknesses of cheesecloth. If the cloth is firmly fastened and the inverted bottle is shaken the surface of water may be uniformly coated with a thin layer of powder.

Using a calibrated pipette, 0.2 ml. of an ether solution of palmitic, stearic or oleic acid, containing 5.0×10^{-6} mole of the acid per ml., is added to the powdered surface. The film will spread rapidly and after contraction ceases, the area of the film is measured. The ether evaporates in a short time leaving a film of solute on the water. From the weight of the solute taken and its density, the volume of the film can be calculated. By dividing the volume of the film by its area the thickness may be obtained, which is also the length of the oriented molecule. The cross-sectional area of the long, stick-shaped molecules may be obtained by dividing the area of the film by the number of molecules in the film. By dividing the length of the hydrocarbon chain by the number of carbon atoms the length per carbon atom is obtained. The values thus obtained for stearic and palmitic acids are somewhat less than the accepted value of 1.54×10^{-8} cm. due to arrangements of the carbon atoms in a zig-zag chain. Some of Langmuir's values are given as follows:

		Cross-section sq. cm. $\times 10^{-16}$	$\sqrt{\text{Cross-section}}$, cm. $\times 10^{-8}$	Length cm. $\times 10^{-8}$	Length/C atom cm. $\times 10^{-8}$
1) Palmitic acid	$C_{15}H_{31}COOH$	21.0	4.6	24.0	1.50
2) Stearic acid	$C_{17}H_{35}COOH$	22.0	4.7	25.0	1.39
3) Cerotic acid	$C_{25}H_{51}COOH$	25.0	5.0	31.0	1.20
4) Tristearin	$(C_{18}H_{35}O_2)_3C_3H_5$	66.0	8.1	25.0	1.32
5) Oleic acid	$C_{17}H_{33}COOH$	46.0	6.8	11.2	0.62
6) Triolein	$(C_{18}H_{33}O_2)_3C_3H_5$	126.0	11.2	13.0	0.69
7) Trielaidin	$(C_{18}H_{33}O_2)_3C_3H_5$	120.0	11.0	13.6	0.72
8) Cetyl palmitate	$C_{15}H_{31}COOC_{16}H_{33}$	23.0	4.8	41.0	2.56
9) Myricyl alcohol	$C_{30}H_{61}OH$	27.0	5.2	41.0	1.37

Further experiments may be performed on the clean water surface next to the powdered surface. A few small pieces of camphor are introduced, using clean forceps. The rapid dancing motion of the particles may be observed. A variation of this experiment and one that has more spectacular appeal to younger students is that of the camphor duck in which a small lump of gum camphor is fastened at the rear end of a toy duck. As the surface tension is decreased the pull toward the rear is released and the duck is propelled forward.

The other end of the trough is dusted with lycopodium powder and various other oils are introduced from clean pipettes not only to study rates of spreading on the water surface, but to observe in which cases lenses are formed. One may use various oils as paraffin oil, engine oil, kerosene, peanut oil, lard oil, sperm oil, olive oil, carbon disulfide, benzene, castor oil, and so forth. In general, mineral oils give flattened globules and animal and vegetable oils spread over the surface.

Finally, five or six drops of paraffin oil are placed upon a clean water surface. A lens is first formed which grows slowly. Before it has spread four cm., in diameter, two drops of oleic acid are placed in the middle of it. In a few seconds the paraffin lens begins to spread with almost explosive violence.

While the theoretical treatment of surface tension outlined here may be somewhat detailed, the author has found that such an approach to the subject gives the student a broader understanding of what actually occurs in boundary layers and enables him to correlate the concept of a change in surface tension with the orientation of molecules at an interface.

ATOMIC PHYSICS IS RIVAL TO BIG TELESCOPES IN SOLVING ASTRONOMICAL PROBLEMS

By furnishing an explanation of how stars are fueled, atomic physics has been responsible for one of the greatest advances in astronomy during the past decade. Big telescopes are not the only means by which the science advances. So declared Dr. Harlow Shapley, director of the Harvard College Observatory, speaking at St. Louis under the auspices of Sigma Xi. He credited Dr. Hans Bethe and his colleagues at Cornell University with the proposal of a plausible method by which, it can be presumed, the stars turn the matter of which they are made into energy, and broadcast it into space.

"It has long been a serious problem" he stated, "to explain why the sun exists at present, and why it radiates at apparently the same rate as it did in Paleozoic times. The ancient plants and animals apparently lived under conditions similar to our own—two hundred million years ago.

"We have long known that if the machinery for transforming matter at the appropriate rate, and at the temperatures existing in the stars, could be found, we could account for the energy source of radiation. The deuterium process, which burns the ever-present hydrogen into helium ash by way of heavy hydrogen; and the carbon stove mechanism, by which the hydrogen goes into the helium ash by way of the transformation of carbon atoms—these two mechanisms appear to be the chief agents in supplying energy for running the universe."

However, the problem is not yet fully solved.

"A great advance has been made," he continued, "but some problems are left over. Where, for example, did the hydrogen come from?" He did not give the answer.

WHAT ABOUT INTEGRATION IN SCIENCE?*

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Although our world and our ideas of truth have always been changing, it would seem that the scientific progress of the last few centuries has greatly accelerated change. Our concepts of the physical universe as well as human relationships are utterly different from those of our grandfathers. Likewise, our ideas regarding the teaching of science are not like those of the nineteenth century. The point of view that science as an organized field of knowledge was a subject of study highly worthy in and of itself is being replaced by an emphasis on the human values of such study. Perhaps it may be called a functional viewpoint or an attitude favoring learning for use. The feeling has been growing that the important outcomes of science study are training values rather than factual information. The scientific attitude and the ability to use the scientific method are considered more important to the individual in meeting his life problems than the memory of facts. The ability to interpret data and to apply scientific principles seem much more useful than knowing those data or principles by heart. This is, of course, not to say that it is undesirable to know facts and principles but rather that such knowledge should be the means to an end and not in itself the end.

It seems to me that this changing conception leads logically and naturally to the integration of the sciences. The maintenance of subject matter boundaries—water-tight compartments—is consistent with the earlier viewpoint. The emphasis on use seems to me to carry with it a disregard for the boundaries of chemistry, biology, physics, etc. as such, and to encourage the fusion and intermingling of all sciences as they add to our understanding of the world about us.

This trend toward the blending of the separate sciences into larger wholes which in turn may eventually merge with other areas, such as mathematics, has been evident for some time. One of our best illustrations of this is general science. Despised and berated by the specialists since its early beginnings less than forty years ago, it has gone merrily along displacing physical geography, and other more "respectable" sciences until today

* Address given at the Second Annual Conference of Science Teachers, California State Teachers College, California, Pennsylvania. October 26, 1940.

it is the most popular science subject in our secondary schools. It has gradually progressed from a hodge-podge of separate sciences based on college textbooks, but with more pictures and less fine print than they had, to a point where genuine integration is being realized.

Another illustration of this trend is high school biology. Second only to general science in enrollment, it has almost entirely replaced the semester of botany and the semester of zoology which used to be taught in the high school. Biology, too, has made great progress in the direction of achieving a real unity and fusion by building around human problems, interests and needs.

Further illustration may be found at the senior high school level in the experiments with physical science courses. Although these are still not common as compared with general science and biology, evidence is accumulating that such courses are filling a real need, especially for the non-college preparatory pupil. Many boys and girls have little interest in separate courses in chemistry and physics, and likewise, little use for them. The new fused courses are intended to meet the interests and needs of this group more effectively than conventional courses in chemistry and physics now do.

One of the most interesting and successful of such experiments has been in progress in Cleveland high schools for nearly a decade.[1] A course, called Senior Science, is a physical science survey for the non-college preparatory pupil. It emphasizes practical applications, consumer education and the social implications of science. An interesting fact is that although substantial numbers of pupils enroll in this course every year, the classes in chemistry and physics are holding up as always. As a result, actually twice as many pupils are now enrolled in 11th and 12th grade science, including the courses in chemistry and physics, as when the latter alone were offered.

Phillips Exeter Academy[2] has been experimenting with a two-year physical science course for some time. Three alternatives are offered students in this area. They may take (a) a year of chemistry and a year of physics, (b) a so-called minor course in chemistry or physics for one year followed by a major course in either for one year, (b) a two-year integrated course in physical

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[1] Bush, George L., "The Need For a Twelve-year Science Program for American Public Schools Symposium." *Science Education*, 22: 64–69. February, 1938.

[2] Hogg, John C., "The Physical Science Course—Its Justification and Sequence." SCHOOL SCIENCE AND MATHEMATICS, 39: 172–177. February, 1939.

science. Among the pertinent findings are (1) that the two-year courses in one science result in higher achievement than one-year courses in chemistry and physics and (2) that the integrated course results in higher achievement than the physical sciences taken separetely.

The survey courses in science at the college level may also be mentioned. Early experiments at this level encountered the same difficulties as the early general science courses, namely, that most of them consisted of six weeks of lectures on chemistry by a chemist, six weeks of lectures on botany by a botanist, and so on. In my own institution we now have three survey courses, one in biological science, one in physical science and one in the social sciences, each in charge of one man, reasonably competent in the major subjects of each field. Their task is to break down the sacred barriers, to let the student see relationships rather than subjects, and to try at all times to have the courses dominated by what adolescents need to know about science rather than what the professor knows best.

Finally, the trend toward integration is evident in the organization of science instruction around principles that are significant in life today. In this method of organization the big idea of generalization is the core of the theme, and science content is adduced as needed to bring about constantly widening and deepening understanding of the generalization. Whether the materials are organized around the "big ideas" of science as suggested by the committee of the National Society for the Study of Education[3] or whether around the areas of life needs and human relationships as suggested by the committee of the Progressive Education Association,[4] the net result is a strong impetus in the direction of integration of science and the overlooking of subject-matter boundaries.

Now having taken most of the time available to describe what has been happening in science education as it relates to this trend toward integration and thereby perhaps clarifying our concept of what integration is, let us briefly examine five or six postulates which I hold to be desirable in furthering and strengthening this trend. I may say, perhaps unnecessarily, that I am in hearty sympathy with the movement. In fact I consider it one of the most encouraging and significant tendencies in science education, and perhaps the best thing that has

[3] N.S.S.E. "A Program for Teaching Science." *Thirty-first Yearbook. Part I.* Bloomington: Public School Publishing Company, 1932.

[4] P.E.A., *Science in General Education.* New York: Appleton, Century Company. 1938.

ever happened to us. Of course, like all good things it can be overdone. However, the greatest danger is in its being underdone rather than overdone. Science, or any other field loses nothing by removal of artificial and unnecessary subject-matter boundaries and by emphasis upon significant and true relationships. This, after all, is what integration means. It can only be overdone in the sense of too much of the sort of thing which characterized our early efforts in general science. However, that is not integration any more than that mixing sand and sugar forms a compound. No combination, no fusion, no integration takes place there. The grains of sand are still completely and totally sand, and the crystals of sugar are unaffected by their proximity to the sand grains. So also neither is a course of one semester of botany and one of zoology, or a year of science consisting of six weeks each of lectures by six different teachers on six different sciences, an integrated course. We have had not too much but rather too little of integration. A superintendent of schools asked me recently if I did not think that fusion of science with geography, number work, and even social studies in elementary grades might result in pupils missing some of the essentials of one subject or another. My only reply would be that I am much more interested in what these youngsters *get* than in what they miss.

What, then, are some of the postulates which seem important? The *first is that integration should begin at the elementary level* This seems true whether we are thinking of science or some other fields. One often hears teachers in high schools complain that pupils do not know what they should have learned in the elementary school. The same complaint is often heard from the lips of college and university teachers. This is probably due as much to variations in background and training of different pupils as to differences in ability. The only way in which differences in training can be eliminated is to give all pupils the same opportunity. It seems probable that science in the elementary school will be taught more regularly and systematically if it is integrated with other subjects than if it must be taught as a separate subject.

Moreover, integration should begin at the elementary level because in most schools the classroom teacher has the responsibility for all instruction, sometimes even including the special subjects such as music and art. Special science teachers at the elementary level are found only in larger school systems and in

laboratory and experimental schools. The regular classroom teacher, therefore, has an unexcelled opportunity to integrate science with other subjects since she controls the instructional program, perhaps more than the teachers at any other levels.

I should like to tell you of a second-grade teacher who conducted her class for one year under a fully integrated program.[5] The major portion of the work was organized about four units: (a) the development and care of a balanced aquarium, (b) a vivarium containing small frogs, toads, crayfish, turtles, etc., (c) a pair of guinea pigs with young, (d) a setting hen and chicks she hatched. These things were all kept and cared for by the children in the schoolroom. Activities included were: reading to find out about the animals and how to care for them; writing, as in invitations to come see the work, thank people for aid, keeping a diary about the guinea pigs, etc.; construction activities as in building a house for the animals; number work as in counting them, measuring the capacity of the aquarium; writing little poems about the various animals and learning songs about them. Many problems arose in connection with keeping the menagerie in the schoolroom but all of them were solved by common sense and patience. No two units were underway simultaneously.

The scores of the pupils on standardized tests given one month before the close of the year indicated that all the children except three had reached or exceeded the standard norms for their age and grade. None were more than two months below. The teacher felt that attainment in attitudes, socialization and group cooperation were even better than that in skills. The parents were much interested and cooperated in many ways with the children and the school.

A second postulate which seems valid to me is that if science is to be integrated and taught well *we need teachers, with much better training in science, especially at the elementary level.* Elementary teachers are sadly deficient in science training. A recent survey in a mid-western state[6] showed that the average number of semester hours of science beyond high school earned by 668 elementary teachers was approximately 15, including courses in geography and health. If these are omitted from the tabulation the average number of semester hours of science for

[5] Linderman, Haziel, "Units of Work in Nature Study for Grade Two." Master of Arts Thesis University of Colorado. 1936.

[6] Davis, Warren M., "Preparation of Ohio Elementary Teachers in the Field of Science." SCHOOL SCIENCE AND MATHEMATICS, 40: 238–243. March, 1940.

these teachers drops to 8. More than three-fourths of them had never taken any courses in nature study and only one out of 16 had had general science at the college level. Over 3% had never had a college course in science of any sort. How can a classroom teacher do anything with science on that amount of training?

Another study of the science required in four-year curricula for elementary teachers in leading teachers colleges[7] shows that the average science requirement for graduation based on a total of 120 semester hours is less than 10 semester hours. The highest requirement in these institutions is 15 semester hours while the lowest is less than 3. It is small wonder that elementary science is neglected, that teachers feel poorly qualified to handle it, and that about all that is done in many places is to have children read a science reader after other lessons are done!

The third point I want to make is that *we need more organized and practical instructional materials, again especially at the elementary level.* Except for some excellent elementary science books now available and some courses of study developed locally by committees, there is a dearth of well-organized, usable, instructional material in elementary science. Some of the state syllabi are so antiquated that teachers despair of getting much help from them, let alone developing any enthusiasm. The lack of training in science typical of elementary teachers and the lack of instructional materials and aids are serious obstacles in the development of an integrated science sequence from first grade through the twelfth. However, the outlook for the future is far from gloomy. Series of science text-books for elementary pupils are appearing, syllabi are being revised or replaced, helpful books on the teaching of science are now available, and a steady stream of useful and practical articles is being published. Teachers of science can find much help in materials of this sort and they will go far toward making the inadequacies of training and experience less serious and embarrassing.

A fourth principle is that *teachers must be made science conscious.* They will find innumerable opportunities in the classroom for science teaching if they but look for them. Too often a child's curiosity is deadened and his interest killed by a teacher who is too busy. Children in the elementary grades are filled with wonder at the world about them. Someone has said that they are in a primitive or savage state so far as under-

[7] N. S. S. C. "A Program for Teaching Science." *Thirty-first Yearbook. Part I.* Public School Publishing Company, Bloomington. 1932.

standing the environment is concerned. Everything about them is strange and new and exciting. The "science conscious" teacher will capitalize on this fact to drive home many a point and encourage an enduring interest. I have heard it said that perhaps science should not be taught in the elementary grades because by the time children reach the junior high school they will be tired of science. To my mind nothing is more unlikely *if* science is made interesting. If it is, their interest will grow rather than decline and the task of the teacher and professor at higher levels will be made easier, at least so far as motivation is concerned. In the words of Robert Louis Stevenson:

> "The world is so full of a number of things,
> I'm sure we should all be as happy as kings."

Although we may be as cynical as we like about the blissful state of kings—those that are left—we may accept the poet's suggestion that the more children know and understand in their environment, the more interesting it will be to them.

A fifth principle that I wish to mention is that *teachers should write about, and publish their experiences.* Classroom teachers often feel too modest about this. They think that no one would be interested in what they have found helpful. Nothing could be more erroneous. While theorists like me can stand and talk indefinitely in terms of principles, it is the teacher who is on the firing line by whose efforts the "refiners fire" is actually applied and the dross burned out. Teachers who lay aside false or escessive modesty and make their experiences available are doing their fellow teachers a great service. Incidentally they do themselves no professional harm by publishing a good article, either. Articles or series of articles like those by McAtee, Phipps, Russell and others,[8] are extremely useful, and practical periodicals like SCHOOL SCIENCE AND MATHEMATICS and *Science Education*, as well as those of a more general character, are glad to publish such material.

Finally, as a last suggestion I would say that *classroom*

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[8] McAtee, Veva, "Materials and Equipment for the Teaching of Elementary Science." SCHOOL SCIENCE AND MATHEMATICS, 39: 15-28. January, 1939.

Phipps, Dorothy V., "Adding Interest to the Elementary Science Classroom. SCHOOL SCIENCE AND MATHEMATICS, 39: 210-218. March, 1939.

Russell, David W., "Suggestions for the Care of Pets in the Elementary School Classroom." SCHOOL SCIENCE AND MATHEMATICS, 39: 354-368. April, 1939.

Fahy, Mildred, "Some Effective Science Activities in the Upper Elementary Grades." SCHOOL SCIENCE AND MATHEMATICS, 39: 450-454. May, 1939.

Forler, Gladys, et al., "Primary Children Experience Science." SCHOOL SCIENCE AND MATHEMATICS, 39: 514-519. June, 1939.

teachers should make a definite place for science in the classroom. Just as we find few special teachers of science at the elementary level, so also we find few science rooms or laboratories there. Science is taught, if at all, in the regular classroom. Under these circumstances, it helps a great deal to have a place for science in the classroom. Perhaps a corner with a table in it can be set aside for science. A small cage for live specimens, an aquarium or bowl, a place to set plants and hang a few pictures are all desirable. Here, too, science books and other reading materials should be placed. Some teachers prefer these things, especially plants, pictures, colored leaves, etc. all around the room. It seems to me, however, that a physical place for science will help to give it room in the instructional program. Whatever plan is followed, science materials and activities must be given definite recognition in the classroom and the program.

In closing I should like to say again that I think integration in science is permanently with us and highly significant. We should work together to understand it better and to improve and support it to the end that we may help create a better world through better science teaching.

AUDUBON NATURE CAMP

The National Audubon Society will conduct the Audubon Nature Camp for Adult Leaders for its sixth season during the summer of 1941. The Camp is located on a spruce covered island in Muscongus Bay, Maine, about sixty-five miles northeast of Portland.

The Camp was established for the special purpose of providing teachers and youth leaders with practical programs for nature study, adapted to their individual needs, and to offer opportunity to observe living plants and animals in their natural environment. Young, experienced specialists conduct a program of field classes in birds, plants, insects, water life, and nature activities, visits are made to a variety of habitats including evergreen forests, hardwood forests, salt water shores and marshes, fresh water ponds, open meadow and outlying oceanic islands.

Campers may enroll for one or more of the following five two-week periods:

June 13 through June 26
June 27 through July 10
July 11 through July 24
August 1 through August 14
August 15 through August 28

For illustrated circular of information write: Camp Department, National Audubon Society, 1006 Fifth Avenue, New York, N. Y.

NEW PROOFS OF THE THEOREM OF PYTHAGORAS

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In this issue of SCHOOL SCIENCE AND MATHEMATICS we present six proofs of the Theorem of Pythagoras together with two converses of this theorem which we believe are new.

The first two proofs are due to Joseph Zelson who was graduated from West Philadelphia High School with the Class of 1940. This young man is already a veteran in devising new proofs of this famous theorem. His first proof was worked out in connection with a special assignment in Mr. I. R. Klingberg's geometry class in West Philadelphia High School in 1938. This proof and eight subsequent proofs were sent to Dr. Loomis. Of these nine proofs Dr. Loomis classified the first, third, and the fifth as variations of known proofs. He accepted the remaining six as new proofs and published them in his second revision of *The Pythagorean Proposition*.[1] Thus, with the publication of the following two proofs, Mr. Zelson now has eight new proofs to his credit.

Proof 1

In Figure 1 we have by construction,

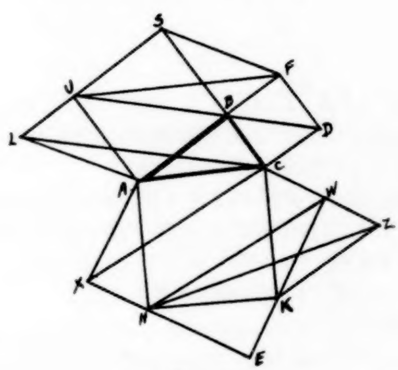


FIG. 1

$$CZ \parallel SF,\ KZ \parallel AB,\ LA \parallel SF,$$
$$WK \perp CZ,\ AX \parallel WK,\ XE \perp WK.$$

It is easy to prove that triangles SBF, ABC, LAU, AXH,

[1] E. S. Loomis, *The Pythagorean Proposition*, 2nd Edition, 1940. Edwards Brothers, Inc., Ann Arbor, Michigan.

HEK, CKW, and WKZ are congruent, and that USF and LAC are respectively congruent to XAC and HKZ.

It then follows that:

$$\begin{aligned}
\text{Square } AK &= \text{hexagon } AXHKZC - 3\,\triangle ABC \\
&= \triangle XAC + \triangle HZW + \square XHWC - 3\,\triangle ABC \\
&= \triangle UFS + \triangle LAC + WZ\cdot EW/2 + CW\cdot WE - 3ABC \\
&= \triangle UFS + \triangle LAC + FD\cdot AF/2 + CD\cdot SC - 3ABC \\
&= \triangle UFS + \triangle LAC + \triangle UDF + \square UDCL - 3ABC \\
&= \text{hexagon } LACDFS - 3ABC \\
&= \text{square } UABS + \text{square } BCDF
\end{aligned}$$

Proof 2

In the construction of Figure 2[2] we should note that

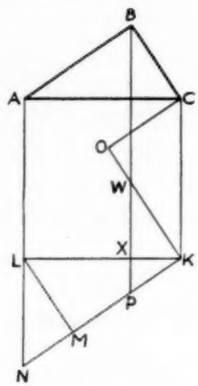


FIG. 2

$NK \| AB$, $BP \perp LK$, $LM \perp NK$, $OK \perp NK$, and $OC \perp BC$.

It is easy to prove that $\triangle LNM \cong \triangle WPK$ and that $\triangle ABC \cong \triangle KOC \cong LMK$. It then follows that

$$\begin{aligned}
\square AK &= \text{pentagon } BANKC - [2\,\triangle ABC + \triangle LMN (\cong \triangle WPK)] \\
&= \square BANP + \square BWKC + \triangle WPK - [2\,\triangle ABC + \triangle LMN \\
&\quad (\cong \triangle WPK)] \\
&= AB(BC+OK) + BC\cdot OC - 2\,\triangle ABC \\
&= \overline{AB}^2 + \overline{BC}^2.
\end{aligned}$$

The third proof is an algebraic proof based on similar triangles. Credit for this proof goes to Irwin Klamen, a sophomore in Soldan High School, St. Louis, Missouri, and a pupil of Alfred Davis.

Proof 3

Let ABC be a right triangle of which ACB is the right angle.

[2] Editor. In this proof the square on the hypotenuse is the only one appearing in the figure.

At B we construct a perpendicular BD which cuts AC extended at D. It follows that

$$\Delta I \sim \Delta II \sim \Delta III$$

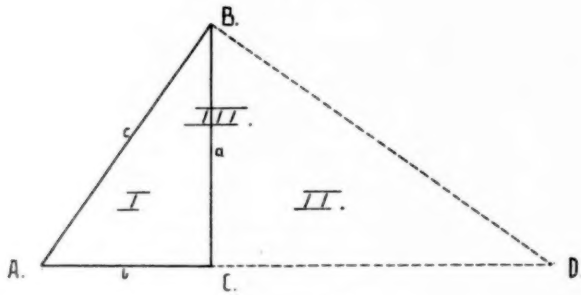


FIG. 3

Hence,

$$\frac{\Delta I}{\Delta III}=\frac{b^2}{c^2}$$

$$\frac{\Delta II}{\Delta III}=\frac{a^2}{c^2}$$

Thus

$$\frac{\Delta I+\Delta II}{\Delta III}=\frac{a^2+b^2}{c^2}$$

Since

$$\Delta I+\Delta II=\Delta III,$$

$$c^2=a^2+b^2$$

The fourth proof is a proof of the converse of the Theorem of Pythagoras considered as a special case of Ptolemy's Theorem which states that the product of the diagonals of a quadrilateral inscriptible in a circle is equal to the sum of the products of the opposite sides.[3] (See Figure 4.) That is,

$$ck=aj+bl.$$

Credit for this proof goes to Bernard Goldman, a senior in Soldan High School and a pupil of Alfred Davis.

Proof 4

In Figure 4 let ABC be a triangle in which we assume that $c^2=a^2+b^2$. We are to prove that triangle ABC is a right triangle. To this end we circumscribe a circle about the triangle. From B

[3] E. S. Loomis, *The Pythagorean Proposition*, 2nd Edition, page 66, Figure 65.

we draw the chord BD equal to the chord AC. We draw the lines AD and CD. We let $BD=l$, $AD=j$, and $CD=k$.

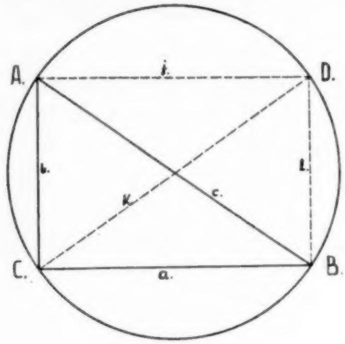


FIG. 4

Then, $\quad \overset{\frown}{AC}=\overset{\frown}{BD}$

and $\quad \overset{\frown}{AC}+\overset{\frown}{CB}=\overset{\frown}{CB}+\overset{\frown}{BD}$

Thus, $\quad \overset{\frown}{ACB}=\overset{\frown}{CBD}$

and $\quad \overset{\frown}{ADB}=\overset{\frown}{CAD}$

Hence $\quad \angle ACB=\frac{1}{2}\overset{\frown}{ADB}$

and $\quad \angle DBC=\frac{1}{2}\overset{\frown}{CAD}$

Thus, $\quad \angle ACB= \angle DBC$

Also, $\quad \angle ABC= \angle DCB$

Since BC is common to triangles ABC and DBC,

$$\triangle ABC \cong \triangle DBC$$

Hence, $\quad k=c$

By Ptolemy's Theorem

$$ck=bl+aj$$

Since $l=b$ and $k=c$, we have

$$c^2=b^2+aj \qquad (1)$$

Subtracting $c^2=a^2+b^2$ from (1), we obtain

$$aj-a^2=0 \qquad (2)$$

Thus, $\quad j=a$

Hence, $ACBD$ is a rectangle.

Thus, $\angle ACB$ is a right angle and $\triangle ABC$ is a right triangle.

Hero's formula for the area of a triangle in terms of the sides, namely,

$$S=\sqrt{s(s-a)(s-b)(s-c)},$$

where $2s=a+b+c$, was derived by Archimedes by the use of similar triangles.[4]

[4] T. L. Heath, *Greek Mathematics*, Vol. II, page 321.

It occurred to the writer that in requiring S to be the area of a right triangle we should be able to obtain the Pythagorean Formula.

Proof 5

Since the area of a triangle may be expressed by Hero's Formula and by the formula $S=\frac{1}{2}bh$, where b represents the base and h the altitude, we have

$$bh=2\sqrt{s(s-a)(s-b)(s-c)} \tag{1}$$
$$4b^2h^2=-[(a+b)^2-c^2][(a-b)^2-c^2] \tag{2}$$
$$4b^2h^2=-[(a^2-b^2)^2-2(a^2+b^2)c^2+c^4] \tag{3}$$
$$4b^2h^2=4a^2b^2-(a^2+b^2-c^2)^2 \tag{4}$$

Let $h=a$, where a is the altitude of a right triangle and b is the base. Then

$$4b^2h^2=4a^2b^2-(a^2+b^2-c^2)^2 \tag{5}$$

Thus, $$c^2=a^2+b^2 \tag{6}$$

Conversely, let $c^2=a^2+b^2$, then from (4)

$$4b^2h^2=4a^2b^2$$

Hence, $h=a$, and thus the triangle is a right triangle.

Figure 5 is a configuration used by the writer in deriving the Mollweide formulas, a modified Law of Tangents, and the half-angle formulas.[5] In this figure we find the segments $c+a$, $c-a$, and b. This combination suggested the possibility of deriving the Pythagorean Formula.[6]

Proof 6

Let ABC be a triangle in which c is greater than a. (See Figure 5.) We add to the side $AB(=c)$ the segment $BE(=a)$.

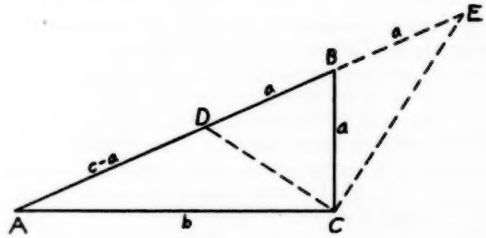


Fig. 5

[5] See School Science and Mathematics. February, 1941, "A Modified Law of Tangents and Other Formulas."

[6] See E. S. Loomis, *The Pythagorean Proposition*, 2nd Edition, page 59, Figure 51, which is a modified form of this figure used by Leibnitz in proving the converse of the Theorem of Pythagoras.

We subtract from the side AB the segment $DB(=a)$. Thus, $AE=c+a$ and $AD=c-a$. We join the points C and D and the points C and E.

It is obvious that triangles BCD and BCE are isosceles triangles and that DCE is a right angle. If we require that ACB be a right angle, it follows that

$$\angle ACD = \angle BEC$$

Thus,
$$\triangle ACE \cong \triangle ADC$$

Hence,
$$\frac{c+a}{b} = \frac{b}{c-a}$$

Or,
$$c^2 = a^2 + b^2$$

Conversely, if $c^2=a^2+b^2$, then ACB is a right angle. This result is obtained by reversing the steps of the proof.

ELECTRON MICROSCOPE IN TWO STAGES MAY INCREASE ITS POWER

Though the electron microscope, which takes pictures with electrons instead of light, has already been used to make magnifications as high as 25,000 times, a new method of using it may even increase its power.

This method was described by Dr. W. V. Houston and Hugh Bradner, of the California Institute of Technology. They use the microscope in two stages.

First, electrons come from a filament similar to an electric lamp. These are focussed by an electrical lens on a thin film which is to be magnified. The electrons passing through are then focussed again by two magnetic lenses, either on a photographic plate, or a screen made of materials which glow with electron bombardment, and thus make the image visible.

U. S. GOVERNMENT STILL NEEDS PHYSICISTS FOR DEFENSE WORK

Because civil service examinations recently announced for physicists needed in the National Defense Program have not produced enough applicants, the requirements for these posts have been simplified.

According to a new announcement by the Civil Service Commission, written examinations will no longer be required for the positions, which are of five grades, with salaries ranging from \$2,600 to \$5,600 per year. Instead, applicants will be rated on their records. Applications will be received until Dec. 12, 1941. Only one application need be filed by a person wishing to apply for two or more places.

The applicant must have completed a 4-year college course with major study in physics, for the higher grades, or at least 24 semester hours in the subject, for the lower. They must also have had professional experience in physics, though for some of this, post-graduate study may be substituted.

Application forms may be obtained from the U. S. Civil Service Commission in Washington, or any first- or second-class post office.

ELISHA S. LOOMIS
1852–1940
TEACHER*

In the death of Dr. Elisha Scott Loomis, Professor Emeritus of Baldwin University and former head of West High School, Cleveland, Ohio, the mathematics profession has lost a well known member. To teachers of geometry he was recognized as *The Authority* on proofs of the Theorem of Pythagoras. He was the author of *The Pythagorean Proposition* published in 1927, a volume which contains 237 independent proofs. Dr. H. A. Naber of Baarn, Holland, has made the following comment on Loomis's investigations on this proposition. (Translation)

"Professor Loomis has wrought in this book a work that is more durable than bronze and that towers higher even than the pyramids" In the summer of 1940 he published the second edition of this book which contains a total of 370 independent proofs.

Dr. Loomis was born on a farm in Wadsworth Township, Medina County, Ohio, September 18, 1852 and died December 11, 1940. As the eldest of eight children, he was left fatherless at the age of twelve years. At this immature age he began work to help support his penniless family. For seven years he worked as a farm hand during summers and attended the district school four months of each winter. During this brief period of schooling he learned enough to take a teaching position in the spring of 1873 at a stipend of fifty dollars. In September of the same year he entered Baldwin University at Berea, Ohio. During another period of seven years he was either teaching in the district schools or attending the University from which he was graduated in 1880 with the degree of B.S. After graduation from the University, he served one year as principal of the Burbank Academy and four years as principal of the Richfield Township High School in Summit County, Ohio. In 1885 he was called by his alma mater to the chair of mathematics in Baldwin University (now Baldwin-Wallace College) to succeed the distinguished Dr. Aaron Schuyler. In 1886 Baldwin University and in 1888 Wooster University conferred upon him respectively the degrees of A.M. and Ph.D. In 1895 he was appointed head of the mathematics department of the West High School of Cleveland, Ohio, a position which he held for twenty-nine years.

Dr. Loomis was a man with wide interests. He was an educator, mathematician, author, genealogist, attorney, and civil engineer. But of all titles conferred upon him he preferred most that of TEACHER, a word which is inscribed on his tombstone. He was the author of a number of books on mathematics and a hundred or more articles on educational, mathematical, and genealogical subjects. He took an active part in the affairs of his community by serving as President of the Board of Education, clerk of Berea, councilman, village solicitor, and village engineer.

* Data furnished by Zoe C. Loomis.

HIKING INTO THE ELEMENTARY SCIENCE CURRICULUM

HERBERT A. SWEET
The Orchard School, Indianapolis, Indiana

[Editor's note. Mr. Sweet agrees with the idea that makes hikes and outdoor trips the focal point of the elementary science program. His success has been outstanding in putting this theory into action. The author is supervisor of the elementary division of the Orchard School and the director of the first country day camp in Indiana. He has also conducted several successful motor trips with groups of boys to different parts of the country making elementary science one of the predominating interests.—D.W.R.]

Hiking has become an integral part of our elementary science curriculum. A well planned, leisurely executed, science collecting trip turned out to be one of the most valuable experiences in the school year. It not only enriched the study of science, but it ramified into all other types of school activities.

A. PRELIMINARY ARRANGEMENTS

A terrarium of ample proportions provided by a parent, and a desire on my part to make the school room an enjoyable place in which to live and work, started an elementary grade on a science study. The response I received upon suggesting it to the class insured plenty of enthusiasm, but it also aroused some fear as to whether the sight of tall trees, broad fields, and clear water, would create a discipline problem. To lessen this danger, each chose his own "collecting projects." Milk-weed pods (all stages), weed seeds (beggars or hitchhikers), fruits, nuts, and seeds (edible), bird nests, insect homes (hibernation), fungi, mushrooms, lichen, reptiles, beetles, amphibians, and wood samples were selected as especially appealing to individuals or groups of two or three. The group as a whole was to look for birds, mammals, and terrarium plants.

B. CONDUCTING THE HIKE

At nine o'clock on a fine fall day, we left school in two station wagons bound for Bacon's Swamp. Each child had his knapsack and lunch. With nets, bait buckets, collecting jars, saws, knives, etc., we looked like a real expedition. Upon arrival, we organized our paraphernalia and put our lunch out of reach of ants, then divided into groups of two or three and set out to collect our specimens. Through past experience I was sure there were no

dangerous spots where the children could go. With two teachers it was possible to keep the groups together so they could use each other's equipment and compare findings.

Wild life is abundant in Indiana, especially around a swamp, so there was plenty of action from the start. Frogs leaped all about us, but they were hard to catch so Ann asked for a fish-hook and rigged it on a pole. She took a bit of red material from surplus in the hem of her skirt and was able to catch a few. Meanwhile, Tom had found a sure way of catching dozens—he went in after them and caught them in the ooze on the bottom of small ponds. Smiley pulled up a frog that was being eaten by a snake, and he let out a yell, but lost the snake!

The bait buckets were being filled with snails and water plants, so I took a small party along the edge of the swamp, which was fringed with woods. The children were amazed at the intricate craftsmanship involved in the making of a nest. Each bird artist used materials and styled his home to his liking. A knapsack I had on my shoulder slowly filled with varieties of seeds. Pawpaws, black walnuts and honey locust pods were a few of the edible kinds, though we found dozens of other tree seeds.

Mitchell used a hack saw he had taken along and obtained twenty-seven sections of tree wood to make a chart of bark and wood specimens.

At lunch we grouped around six fires built by Boy Scouts of the party. Some passed their second class fire building tests, using only wild wood materials and two matches. We soon had steaks, baked potatoes, and canned foods cooking to the satisfaction of all. Every one ate so much you could not give away such delicacies as cookies and chocolate bars.

After lunch one of the most valuable half hours of the trip occurred when there was a spontaneous discussion of all the morning's happenings. This certainly was one of the products of an unhurried trip. While we were waiting for our lunches to settle, Tom gathered up all the spare pickle and olive jars and "pickled" a few of our specimens by injecting them with alcohol and placing them into the jars filled with preservative.

Since all were anxious to complete their work, we spent two more hours after lunch just collecting. Then at a signal from the car horn, we all gathered, ready to start home. Station wagons have roomy tailgates which let down for luggage. We loaded these with all we could possibly carry. Inside the cars

each child had in his lap his special little pet thing that had to be handled with care. I am sure that every one would have kept busy until dark if we had not set four o'clock for our arrival back at school.

C. OUTCOMES OF THE TRIP[1]

The success of our excursion was more apparent the minute we arrived on the school grounds. Lindbergh could not have felt more triumphant when he entered Paris! We were swamped by children eager to see the results of our expedition. What is that? Let me see it? Is it alive? May we go sometime? May we come to your room? These were just a few of the many questions asked about our day.

The following day in the lunchroom stories about the trip were told and on several tables were displayed the findings related to each child's specialty.

The excitement of the trip itself soon died down, and in its place came a seriousness that was noticeable. Each school activity seemed to benefit in various ways. Some very obvious results turned up in the following classrooms:

Drawing. The children immediately wanted to record in a more or less scientific drawing, details of specimens brought in. Fungi were perishable and must be drawn or kept as a memory. Seventeen distinct varieties were pictured. Seeds were drawn even down to "worm" passageways through acorns. No better way of developing observation could be found. In regular art work marshland was the theme.

Spelling. The nomenclature of objects on their drawings necessitated the learning of dozens of new words. The labeling of charts for public view demanded correct spelling. The keeping of bird check lists added many more.

Arithmetic. We found many problems could be made more interesting by relating them to our hike.

Geography. The muck, representing deposits of partly decayed organic matter several feet thick gave us a good lesson in physical geography. It has much to do with the character of the water and the vegetation and animal life of the territory. This led to comparisons with seashores, woods and deserts.

History. Local history of Bacon's swamp was explained by an

[1] Editor's note: In the April, 1940, Vol. XL, Number 4 issue of SCHOOL SCIENCE AND MATHEMATICS, Gladys Lodge of Albany, New York, presented some interesting aspects of planning nature trails in her article, "Pitfalls and Peaks of Nature Trails." In this article are mentioned some of the "techniques" to avoid when planning field trips for children. See also "Planned Field Trips—An Integral Part of Science Units," by Dora Wood, SCHOOL SCIENCE AND MATHEMATICS, Jan. 1941 Vol. XLI, No. 1, pp. 28–35.

old gentleman who happened by while we were eating lunch. Ancient times were suggested when they thought of the time required to build up the layers of muck. It took us into the study of prehistoric Indiana.

Reading. Boys who never picked up books without being told, wanted to know the whole story about newts, snakes, and turtles. This gave me an opportunity to suggest library books such as Ditmar's *Book of Living Reptiles,* and many of Ernest Thompson Seton's books.

Shop. Instruments for measuring the height of trees, display boards, terrariums, and cages, received special attention.

The home room benefited by the results of these numerous activities. The walls never failed to have pictures; the terrarium was inspected each morning for changes. At one time most of the school came visiting to watch a snake shedding its skin.

Best of all, a genuine interest in science was started which gave us all a common tie. In the spring, bird walks and studies of conservation took us afield again.

Since then, I have been called many times at night to answer questions about injured birds, migratory birds, and other subjects about wild life. We have something in common which offers an opportunity for guidance that cannot be reached in everyday classroom experiences.

We now feel so convinced that hiking has much value that we have taken trips to Wyandotte Cave, state park, and innumerable short trips with small objectives.

THE PARACHUTE IN THE U. S. FOREST SERVICE

Parachute-jumping forest fire fighters can save the government a good deal of money, it appears from experiences in the West, reported to the U. S. Forest Service.

The Forest Service keeps close track of the cost of suppressing forest fires. In 1934, a fire in the Nez Perce National Forest in northern Idaho cost $12,000 to put out, when fire-fighting crews moved in by truck and on foot. During the fire season just closed, another fire occurred in the same area. This time two parachute jumps formed the spearhead of the attack, and the cost was held down to $500.

Another comparison was made even more directly, when ten fires were reported in one day, in the Bitterroot National Forest in Montana. Two of them, in inaccessible areas, looked as though they might become bad ones, so planes flew over and dropped crews of "smoke jumpers," with tools and provisions. The other eight were attacked in the orthodox manner, by crews going on foot from roadheads.

It cost only $160 apiece to suppress the fires attacked by the parachutists. The ones put out by ground crews alone cost from $2,000 to $17,000 apiece.

MAKING HIGH SCHOOL CHEMISTRY MORE FUNCTIONAL

Harold H. Metcalf
Oak Park-River Forest Twp. High School, Oak Park, Illinois

"As a high school chemistry teacher, I must decide what is best for my pupils, some of whom are going to college, some into technical work, and some who have not planned their futures." Last fall I asked my pupils why they had elected chemistry. Their answers indicated that 20% intend to take chemistry or engineering in college; 10% intend to take medicine; 15% intend to become nurses, laboratory assistants, or home economics students; and 55% think chemistry is of general interest and utility. About 40% are girls and 60% are boys. One boy said "I think that chemistry will determine the future of the world." That is not far from the truth. As we all know, the chemists have rapidly changed the materials used for clothing, housing, feeding, and transporting the peoples of the world. They have developed the alloys used in the manufacture of airplanes and the high octane fuels necessary for their efficient operation. As a teacher in high school, I must teach chemistry in such a way that it will be functional in the lives of all who have elected to take it.

Chemistry is a special field in science which is quite clearly defined. Is total emphasis on content of a purely chemical nature justified in high school? A number of research studies seem to indicate that it is futile to expect pupils to remember much factual data. Prof. S. R. Powers, on the basis of extensive study, stated, "A large proportion of high school chemistry is of little value to those studying it. Many students and even entire classes often obtain little mastery of the subject and much of the mastery is rapidly lost after the student has had the course." Ralph Tyler, head of the dept. of education at the University of Chicago, has made studies of retention in high school science courses. He states, "Specific facts are largely forgotten. A year after taking the course, the students recalled only one half of the facts which they knew when taking the course. Facts and principles of more general application are, however, not so easily forgotten. One year later the students recalled 85% of them. In adjusting the curriculum, emphasis upon objectives, which are not only of great social significance but also represent permanent changes in student's behavior, seems possible when we

rid ourselves of the misconception that all learning is followed by a rapid curve of forgetting." The opinions of Dr. Powers, Dr. Tyler, and of others who have done research in the field of science teaching are in agreement with the opinions of many teachers of high school chemistry. Present textbooks are larger and all inclusive. Teachers must make choices. It is inadvisable to hurry over all of the descriptive phases of chemistry in order to get through the book or prepare for college chemistry.

Figures indicate that teachers of chemistry have recently been and are doing a fairly good job. The romance of chemistry still has a great appeal to pupils. Good teachers and good texts emphasize the teaching of principles. Educators have been heard to say, "Chemistry is losing its place in the curriculum. 10.1% of all secondary school pupils took the course in 1890 but in 1934 only 6.04% were enrolled." Such statements are meaningless in light of the great change in total size of the high school population and in light of the changing character of the pupils.

In the United States in 1928, 204,694 high school pupils were enrolled in chemistry; in 1934, 342,659 were enrolled. In 1928, 4,783 high schools offered chemistry; in 1934, 6,662 schools. In that short span of six years, the number of pupils taking chemistry had increased by 138,000 or 56% and the number of schools offering chemistry had increased by 1,879 or 39%. As chemistry teachers, we must change our course to fit this increase in numbers and the change in character of population electing it.

In view of the data presented, it is evident that College Board Examinations and Minimum Essentials established by the American Chemical Society previous to 1928 should not dominate the teaching of high school chemistry. The American Chemical Society has, however, taken an important step in the direction of helping high school chemistry teachers. Mr. Martin V. McGill, with the help of the members of the high school chemistry committee of the American Chemical Society conducted a Workshop in High School Chemistry at Western Reserve University in Cleveland, Ohio, during the summer of 1940. The Suggested Course in High School Chemistry, which was developed at the Workshop and is now in print, is a great change from the old outline which was sponsored by the society in the 20's. It is a start in a new direction and all high school chemistry teachers can derive help from it. In most every high school, the course is elected by some pupils as a foundation for further

specialization in the field but by a majority for the purposes of general education. Chemistry is unique in that it can meet the general education objective in large measure by the teacher giving emphasis to the contributions which chemistry makes to healthful personal and social living, to an understanding of the scientist's view of the universe, to intelligent consumership, and to orientation to work. The body is a machine in which biochemical processes are constantly going on. Some understanding of these processes and of the effects of foods and drugs on them is important. Chemistry can answer the question, "Is a highly advertized pill or a balanced diet of more importance to good health?" Chemistry has helped much to make living in large social groups hygienically possible through water purification, sanitary sewage disposal, protection against impure and adulterated foods, development of healthful food preserving processes, development of antiseptics, development of drugs, and in other ways that should be studied in high school chemistry. The nature of the structure of matter with its many particles and orbits has a counter part in the bodies of the universe. Boys and girls are fascinated by these studies and they can be helped to better understand their place in the world of things and people. To buy and to consume intelligently, are as important to the individual and to the nation as to manufacture and make goods available for consumption. Since so many marketable products are of a chemical nature, it is the responsibility of the teacher to consciously guide pupils to become intelligent consumers. Dr. George L. Bush of Cleveland has written *Science Education in Consumer Buying*. It is in print now and will be a valuable addition to a teacher's library. Dr. Bush maintains that performing a few laboratory exercises on the amount of alkali in soap or of the available carbon dioxide in various brands of baking powder are not in themselves sufficient in teaching consumership. He points out that there are many government and other agencies which will supply free or at low cost information on products used in housing, clothing, drugs, cosmetics, hair removers, hair growers, fertilizers, and foods. The teacher should take advantage of opportunities that occur daily to work consumer information into the course. The teacher can also help a pupil to orient himself to whatever occupation he plans to follow. The chemistry class room and laboratory give opportunity for some effective guidance in the choice of life work. Some teachers survey the job opportunities in the locality

of the school, study the employer's needs, and fit pupils for specific work.

Some one has made the statement that the greatest need in a democracy is critical thinking on the part of its people. Whether you agree or not, the laboratory work is most effective when it stresses the methods used by the scientist in solving problems. Simple exercises may be used at first to develop skills and give meaning to words. As the year progresses, the problems should become more complex and greater initiative should be required in order to plan the methods to be used in their solution. One cannot master a technique of problem solving by memorizing a few routine steps. Much practice is required and the laboratory is ideal for such practice.

In these days of international ill feeling among nations, our democratic way of life seems to take on new meaning. What better place is there in which to teach community living than in the laboratory. The pupils are free to go about the room to get the necessary supplies and materials. On some experiments, groups work together. Sloppy work or rowdiness in any form interferes with efficiency and accomplishment of others. Use of chemicals to make explosives or doing other types of experiments not sanctioned by the teacher endangers the pupil and those about him. In the well conducted high school chemistry laboratory, the personal dignity of each student is preserved. Each has a sense of direction, and causes no inconvenience or interference to those about him. Yet there is a friendliness in the atmosphere which exists when there is common purpose. Under such conditions, the teacher is available for help to those who need him.

Thus far in the paper, some of the general objectives in chemistry teaching have been emphasized. In designing a course of study, objectives are often listed for purposes of satisfying the requirements of the school or to catch the eye of the administrator. However, the teacher is daily making choices of content and approach. Real progress can be made toward the achievement of worth while objectives if the right choices and emphases are selected. A graduate of a high school who understands how to care for his own body, how to live healthfully with others, who has an understanding of the materials and bodies of the universe, who understands how to buy intelligently, who knows how to do a job well, and who critically thinks through a problem before reaching a conclusion is well prepared.

With your permission, I am going to point out some of the things the chemistry teachers in our high school are doing. Dr. C. E. Osborne who, previous to his death in 1938, was head of the chemistry department in Oak Park High School, said in a speech before the American Chemical Society in 1924, "The most important factor in the class room is the teacher, a real and not an artificial teacher. He must be interested in and understand young people. He must know their problems and experiences. He should know the applications of chemistry so familiarly that he lives his chemistry." Each of the teachers in our chemistry department approaches the problem of teaching in a different manner but each does an effective job. Pupils hear about the course from those who are enrolled and approximately 360 of the 3,600 students of our four year high school elect chemistry. This means that about forty percent of each graduating class have taken the subject. Since chemistry is only one of six advanced, elective sciences, the students must think that chemistry is functional in their lives.

To do the job well is the dominant influence during the first semester. The vocabulary of chemistry is extensive and difficult for beginners. The principles learned in the first semester serve as a foundation for thinking in the whole science area. Laboratory skills and techniques must be mastered. Valence, formulas, equations, and problems require thorough and painstaking treatment lest pupils become lost. The tie up with the daily life of the students is important. Illustrations from outside the laboratory are brought in at every opportunity. During the whole first semester, speed is sacrificed to thoroughness. The text we are using is well planned and is understandable. Pupils learn to use it and depend on it for help.

The chemistry teachers of our department are writing the experiments. Each teacher uses a somewhat different approach and style. The needs and capacities of the pupils are kept in mind as well as the facilities available in the laboratory. Some of these experiments are quite similar to the traditional type. Others demand greater resourcefulness in planning. We do not use a work book. The experience of writing the experiments and the criticisms offered by the pupils have a healthful effect on the course and the teacher. An attempt is made to have the class and laboratory work closely related and interdependent. Every high school teacher should write his own experiments as a means of self-improvement as well as of course improvement.

Extensive use is made of the magazines, books, and newspapers. Great chemists of the past become a healthful influence. Chemistry is unique in that research has shown that more is written in newspapers relating to chemistry than to any other science. A bulletin board or a scrap book adds interest and understanding.

Demonstrations are set up by the teacher or by groups of pupils whenever work in the laboratory is insufficient for teaching a principle.

School exhibits have been effective in selling chemistry to the public. The individual pupils work out projects and during the exhibit are busy at work at their desks. The parents wander from pupil to pupil asking questions and are usually favorably impressed by the knowledge exhibited.

A chemistry club of approximately 50 members meets every second Tuesday after school. Student members elect their own officers, conduct the meetings, and plan their programs. Though the members prepare many of the demonstrations and talks, the club sometimes invites teachers or scientists of the community to talk before it. Dr. J. C. Morrell, a prominent member of the American Chemical Society and an authority on petroleum chemistry, has talked before the club annually. Last year he flew home from Washington to keep the date and he says that he is now getting applications for jobs from former Oak Park students who heard him talk before the club. Trips to such industries as Illinois Steel, Universal Oil Products, Abbott Laboratories, Bowman Dairy Company, Chicago By-products Coke Company, and the American Can Company are greatly appreciated by the members.

One of the important aspects of student health is controlled by the chemistry department. Under its supervision, the water in the swimming pools is tested daily. Pupils sterilize apparatus, prepare agar, take water samples from the swimming pools, incubate and count bacteria colonies, determine excess chlorine, and recommend treatment of the water. The membership of the groups is changed regularly by the teacher so that many pupils benefit from the experience of water testing.

Motion pictures are used for class work as often as they make a worthwhile contribution to the course. Usually the teacher gives some guidance on the nature of the film, often shows the film twice, and then conducts a discussion or examination on the content. If a film does not meet expectations, it is rejected.

During the first semester, the teachers cover about the same ground and make approximately the same progress. I have heard many chemistry teachers complain about the second semester. Pupils often lose interest and the subject matter often lacks continuity. Since it is impossible to cover the whole field of chemistry, the second semester affords real opportunity for more freedom of selection and planning. Ingenuity is required to maintain interest. Often a teacher can do his most effective work in the second semester by intensively exploring a field that is his hobby. Students pick up this teacher enthusiasm and are motivated to do exceptional work. Organic chemistry and qualitative analysis are effectively taught by some teachers and not by others. I have a friend in the Denby High School in Detroit who centers the teaching of physics around the automobile. He says that there is great interest and also a feeling on the part of the pupils that they are deriving information and skills that will be of vocational value to them. The automobile depends on chemistry for metallic alloys, lacquers, fuels, rubber, plastics, glass, and in some cases fabrics. The gasoline engine is excellent for demonstrating and studying the gas laws. I believe that if I were in the Detroit area I would build my chemistry course around the automobile.

During the last two years, some of my students have become interested in soil study. They have tested and corrected soils of their lawns at home. Some have made studies of fertilizers, some of the nitrogen cycle in nature, some have studied the effect of soil acidity on plant growth, and others have taken up the growth of plants in chemical solutions. Although chemiculture of plants does not have much practical value in this locality, the idea captivates pupils and they develop an interest and a hobby that brings them back to school during the summer and the next year asking for chemicals. Through such a study of soil, the interrelations between living organisms and the non-living are readily seen and better understood. The interdependence of the sciences of biology, geology, physics, chemistry, and sociology are also brought to the fore.

During the first semester the teacher has opportunity and is obligated to study each pupil's abilities, interests, attitudes, and needs. In the words of Dr. Conant, president of Harvard University, "Our schools must be concerned with educating for a useful life of a great variety of boys and girls. They should be concerned not only with the able scholar, but with the artist

and the craftsman. The problem of each boy and girl is difficult. Abilities must be assessed, talents must be developed, ambitions guided. On our ability to handle intelligently all types of the heterogeneous students of the secondary schools, depends in large measure the future of this country." I believe that each pupil should be given opportunity in the second semester to do some work on individual problems of the nature of the soils study. Too few high school students in the middle west realize the importance of the soil to their welfare. Other fields from which problems may be selected are: fuels, metals, health, drugs, cosmetics, foods, and petroleum. Mechanically, there are a number of ways of doing individual problem or project work. A friend of mine in Des Moines, Iowa, plans for one laboratory period a week in the second semester to be used by the pupils in working on problems approved by him. Most of the students have enough self-direction to make progress during this time, but formal work is planned for those who either do not select projects or do not properly use their time. One of the men in our school conducts this type of work. Each pupil or group presents the material before the class near the end of the semester. The teacher draws from these class presentations the questions for a written examination. The whole class benefits from the work done by each individual.

Working in such a field as petroleum offers much opportunity. Distillation of crude oil in the laboratory involves an element of danger, and pupils working on such experiments need help and supervision. Taking off and studying a few fractions gives background for reading and trips to industrial plants. But the study of petroleum leads into the general problem of conservation of natural resources. The pupil learns of the contributions of the chemist to the petroleum industry, of the increases in the production of gasoline from a barrel of crude oil through the use of cracking and polymerization processes. He also learns that the supply of petroleum is exhaustible. The teacher of chemistry is able to show the basis for attitudes that will prevent waste in the future. A case which illustrates the point comes from my own state of Illinois which was third in the production of crude oil in the country until a few months ago. The *Chicago Daily News* made the following statement on September 4th: "The rapid decline in production of Illinois crude is in line with the predictions made by leaders in the oil industry that the wastage incident to the uncontrolled drilling campaign would result in

quick exhaustion of shallow pools. Not only were these wells drilled too close together but no effort was made to maintain a gas pressure so necessary for an economical withdrawal of the oil from its natural storage in the ground." The implications of this situation for education are given by Dr. Laurance Palmer of Cornell University writing in the *Nature Magazine* of August-September. "There is every probability that eventually we will be faced in this country with some program that will require universal training of our youth in the wise use of our natural resources for the national good. That time may come sooner than expected, and when it does come there will be a mad scramble of most people to find their place in the general scheme of things. Conservation education must, of necessity, play an important part in this picture." Chemistry offers unlimited openings in this field.

In conclusion then, I am not suggesting a softening up of the educative process in the secondary high school course. The Chemistry teacher is challenged by greater problems than ever before to make chemistry function in the lives of all pupils: His teaching must result in:

(1) A sound foundation in chemical principles.
(2) Emphasis on content that will aid all to meet the problems of living in a complex social environment.
(3) Attitudes that will help to preserve the resources of our democracy.
(4) Practice in critical thinking that it may become a valuable tool rather than a meaningless symbol.

MINERAL PRODUCTION IN ALASKA

With total gold production valued at approximately $25,375,000 during the past year, Alaska hit an all-time record which surpassed even the great gold rush days, W. C. Mendenhall, Director of the Geological Survey said in a preliminary report of the Territory's total 1940 mineral production.

This amount is nearly $2,100,000 more than the value of gold output in 1939 and brings the total value of gold production in Alaska, from the beginning of recorded mining in 1880, which was 13 years after the Territory was purchased from Russia for $7,200,000, to the present, to about $561,311,000.

In 1940 production of other minerals besides gold, including platinum metals, tin, antimony, quicksilver and coal increased in quantity and value. The entire production of all minerals for the year was valued at approximately $27,658,000—nine and one-fourth per cent more than in 1939.

The 1940 production brings the total value of all minerals produced in Alaska since 1880 to more than $830,000,000, Director Mendenhall stated.

SCIENCE IN THE ELEMENTARY SCHOOL

Central Association of Science and Mathematics Teachers Round Table Discussion

Saturday, November 23, 1940

Miss Mary Melrose, Supervisor of Elementary Science, Cleveland, Presiding

Miss Melrose: My task this morning is a pleasant one, I assure you—that of introducing the members of this discussion group. They represent various positions and different types of educational experience. Yet, all are concerned with the subject of science in the elementary school.

Members of the Round Table:

Chairman—Dr. G. P. Cahoon, College of Education, Ohio State University, Columbus, Ohio

Dr. Paul E. Kambly, Head, Science Dept., University Experimental School, Iowa State University, Iowa City, Iowa

Mr. H. M. Buckley, Assistant Superintendent, Cleveland Public Schools

Dr. David W. Russell, National College of Education, Evanston, Illinois

Mr. W. L. Shuman, Ass't Supt., Cuyahoga County Schools, Cleveland, Ohio

Miss Anna E. Burgess, Principal, Doan School, Cleveland, Ohio

Mrs. Ethel K. Howard, Supervisor of Elementary Instruction, Board of Education, Lakewood, Ohio

Dr. Cahoon: Thank you, Miss Melrose. The general plan we thought we would follow would be to ask some questions of these folks on the panel—questions that have been suggested, similar to the ones which are listed on the program. We shall have to be brief in our discussion because of our time limit.

Now I should like to make one other preliminary suggestion. If anyone in the audience has a question which you would like to have the panel discuss, will you please write it and give it to Miss Melrose. We shall try to include these in our discussion. At any time during the discussion, if some point is brought up which you would like to have discussed further, please feel free to let us know.

Miss Melrose gave us a list of 16 or 20 questions. Obviously,

we cannot discuss all of these. Suppose we select a question and get started. Let us assume that this group knows something about what is ordinarily included in the teaching of elementary science. About teachers in service: How can they become better teachers, particularly when they don't have too good a science background? Mr. Buckley, will you start us on this question?

MR. BUCKLEY: I am interested in how teachers can grow in this field because I am convinced that that teacher is the best teacher who is growing all along the line. There was a great deal of complaint when we started elementary science, branching from nature study into the comprehensive type of educational content in the elementary schools, because the teachers were not trained in the very wide and basic field of science. But I think my theory is sound that the learning on the part of the teacher is an asset. If I had to choose between someone who felt entirely satisfied or someone who says, "I don't know enough to teach them, but I am willing to learn," I would certainly choose the latter.

DR. CAHOON: Miss Burgess, you have had some experience with folks who have not had such good background for the teaching of elementary science. Will you tell us what your reaction is?

MISS BURGESS: I would rather start with the teacher who is a good teacher of children, than the teacher who is absolutely sure of her science subject matter but who does not have the ability to teach children. However, we do get a great many teachers who want to improve their background in science teaching. Many teachers study a unit with the children, then perhaps they go to high school textbooks on the same subject and then into a college course. I think each teacher who plans to continue to teach elementary science ought to lay out her plan of college courses to fill in the weak spots in her background. Then, in order to continue her growth, she ought to plan to take courses quite frequently because science changes so rapidly. A teacher might also improve in a section where there were no college courses available by means of reading. There are some very good books available for educators and for the layman adult. Then, too, in almost every neighborhood there is an enthusiastic person who knows about birds or flowers, or who is making a rock collection, fossil collection, etc.

DR. CAHOON: That sounds reasonable. One of the things I have noticed in connection with the elementary science teachers

who come back to college after running up against this problem is that they don't know where to begin. They are expected to teach elementary science and they are a little bit afraid of it. They think in terms of physics, chemistry, botany, and astronomy. It looks like a formidable array of subject matter.

Dr. Russell, you are in the teacher-training field. What suggestions can you give us?

Dr. Russell: Science orientation courses that are now being offered are openly under fire because it is claimed they don't dig deep enough into the subject and that they cover too much in one year.

However, I am a firm believer in orientation courses. I believe that a good teacher should know something about what she is going to teach. I think you have to combine the two. There are two simple ways to learn science. One is by reading a good orientation science book, or you can join a nature study club and before long you will find that you are going beyond what you had intended to do, and you will be a better science teacher. Keep within the children's interest, but keep above their level.

Dr. Cahoon: Speaking of subject matter, raises another question that I think many of us are concerned with. What are some of these common subject matter errors which are made by elementary science students? Dr. Kambly, you have contact with pupils in the elementary schools—what are some of these common subject matter errors?

Dr. Kambly: There are a good many rather common subject matter errors. I shall comment on just a few that I have noticed. One involves the classification of insects. In our own school, pupils insist on saying that an insect is not an animal. They also separate birds from animals. My own opinion is that this comes about as a result of reading the unfortunate phrases "insects and animals," "birds and animals."

Another one of the most common errors made concerns the respiratory activities of plants. That plants do not use oxygen in respiration would be the logical conclusion as the result of studying the aquarium. The teacher must make a special effort to correct it. The plants in an aquarium give off oxygen and use carbon-dioxide. However, they also use oxygen in their respiratory activities. Teachers often neglect to emphasize this point.

The next error I would like to mention has to do with what you might call teleological interpretations. "The plant does this because it is trying to." "The animal is working hard to protect

itself from." "The leaves are trying to get light." These are statements which you may have a tendency to make, but which are wrong because they suggest purposive adaptation.

DR. CAHOON: What about the use of "Mother Nature?"

DR. KAMBLY: That does not bother me so much in the elementary school.

MISS BURGESS: We should certainly object to it.

DR. KAMBLY: Perhaps you are right. I would not object to "Mother Nature" at the lower levels.

MR. BUCKLEY: I am not sure that any science teacher could know enough in these various fields to keep from making mistakes. As a matter of fact, somebody told me when I started to learn a bit of science that it is only the carbon dioxide that plants give off. I read last night in the *Life* magazine that we were looking up at a nebula that is 2,300,000,000 suns in size. I am not sure whether it makes a whole lot of difference whether it is a trillion or a million suns in size, but I think that you could get the idea over to the child. Two thousand—three hundred million times the size of a sun—is that an idea that would be comprehensible to a child? Do we comprehend it? Isn't the general effect of a statement like that more important than statistical exactness?

DR. KAMBLY: Where there is specific information which makes a difference in further science study, the teacher ought to use the correct information.

I should like to discuss one more point. Experiments in elementary science are supposed to help attain the time-worn objective of training in the use of the scientific method. Most people who are teaching science perform "experiments." I think they should perform experiments in such a way that the pupil learns to be logical—to think. Too many people do not run check experiments. This raises the question—Is there a difference between an experiment and a demonstration? Are there times when we simply would like to demonstrate? If we experiment, let us take into consideration every factor which affects the results and run checks on each of these factors.

DR. RUSSELL: I agree with Mr. Buckley. We are not teaching physiology, chemistry, or biology in the elementary schools in laboratory work. We are teaching the first and second grades. We should teach science so that youngsters of that age are going to like it. I am partly opposed to a lengthy series of experiments prescribed by educational authorities in so far as they contribute

nothing as a whole. This is a high school technique.

DR. KAMBLY: Not a high school technique—it is a science technique.

DR. CAHOON: I agree with that, for there may be science techniques in the lower grades.

MR. BUCKLEY: The habit of observation is what you were talking about. It is a very valuable thing. I visited Doan School one day when the children had two flying squirrels which got out of the cage and were running about the room. Some youngster was reading a book written by a science man who had said that a flying squirrel is quite helpless on the ground. He turned to the page quickly and said, "This author says that the flying squirrel is quite helpless on the ground, but these two boys can't catch the squirrels." The squirrels did not seem to be very helpless.

This makes me think of the subject of witch-burning. One man in Germany burned 900 witches. If he had had the training to observe whether it was the witches that caused storms or disease, I believe this would not have happened. If we can teach children to question and observe and then find all the evidence available before making up their minds, we have rendered a profound service.

MR. SHUMAN: Mr. Chairman, I would like to talk about a different type of error, which I think is even more important. For instance, did you ever hear that a camel could go nine days without water? Actually the camel does not have any water pouch. And yet, in one of the textbooks only last summer I read that this animal has a water pouch.

There is one question that I asked in grammar school—"What causes the report when a gun is fired?" The teacher said the report is caused by the air rushing in to fill up the vacuum. I asked the same question in high school in my physics class, and received a similar answer. How could there be a vacuum there—only tons of pressure. There is no vacuum. The report is caused by the rapid expansion of the gas as it leaves the gun.

DR. CAHOON: Well, we have had some of the "don'ts." What are some of the "do's"? Mrs. Howard, what are your reactions?

MRS. HOWARD: I think, first of all, any experimenting that we do in the elementary school should be pupil motivated if it is to be effective. A teacher can ask, "Are we interested in this?" If we find something that the child really wants to do, it should be met with an enthusiastic response on the part of the teacher.

Once she finds what the children are interested in, I think that she should further this interest. It should, however, be very simple. I am very much opposed to elaborate equipment in the science room. Most effective teaching is done if the materials are made by the children or brought in by them. It may take time, but it is worth the extra effort. Some of the things brought in from home are very crude, but I think that if the child had enough interest to bring in the article, the teacher should be willing to display it and talk about it.

I think a text should be used last. We do not hesitate to bring people in to talk to the children. We also ask the children to bring their parents to these talks also. We have quite a few field trips in Lakewood, but I feel that these should be very well planned and developed by the class so that every bit of time may be a very valuable experience. This planning is done by the pupils with the teacher's help.

DR. CAHOON: What about the place of reading materials in the elementary science program? I second the idea that we ought to use real things. Does that mean we should minimize reading, or where does it come in?

MR. BUCKLEY: A child expresses real joy when he picks up his textbook and finds that what he has learned is written in the book, black on white.

DR. RUSSELL: Reading has met needs in many cases. One study in reading techniques of children found that children do not comprehend science materials as well as social science materials. Of course, the reason is that much of the science vocabulary has not, up to the present time, been included in the readers. Reading comprehension in science is lower than in the other subjects.

MISS BURGESS: Dr. Russell, I think this depends upon the experience children have had. They can get additional information from textbooks and check what they have already learned.

DR. RUSSELL: Yes, I should have mentioned experience. That is a very important part.

MISS BURGESS: Children do a great deal more reading as a result of science teaching than without it. They find answers to questions in textbooks. They find suggestions for further things to do.

DR. RUSSELL: I think there are two most important problems in science: Reading and Health.

MR. BUCKLEY: I would like to ask a question of these science

experts. If someone has spent his life on one phase of science, how is he going to relate the various fields to the child's experience? In a short lifetime the child cannot experience many phases of the various fields of science. It seems to me that what the elementary school should do is to bring to the attention of the child a sufficient number of stimulating units to stimulate his imagination, especially in the fields where he can never have the time or opportunity to learn by direct scientific experience.

MR. RUSSELL: Modern teaching says that the child should learn about the things he is going to use. There are certain experiments which the child needs. He would not need some of these experiments unless he is going to high school.

DR. KAMBLY: Please tell me why he needs those experiments. You said he will need them when he gets in high school.

DR. RUSSELL: I should have put "needs" in quotation marks. I have had experience in teaching college preparatory work, and, frankly, the college insists on children learning certain specific experiments. In many high schools they have stereotyped experiments which students must perform. I admit the point to you there.

MRS. HOWARD: Haven't we come a long way because we have considered what the child needs and disregarded what the high school needs?

DR. CAHOON: Let us talk about activities and experiences which most of us have to deal with in an elementary school program. Shall we go through the same activities at the same time, or can you provide what have often been called "projects" and let each pupil work on a different project?

MRS. HOWARD: A stereotyped course in science is almost impossible in the elementary school. Each group will work differently. I think the science teacher has to be most alert, most alive and a most enthusiastic individual.

DR. RUSSELL: Enthusiasm is an important trait in a teacher.

MISS BURGESS: I think a big general plan underlying the program of elementary science is a good thing. There are certain experiences in elementary science which a child should get in the elementary school. It is therefore advantageous to have a suggestive course of study.

MR. BUCKLEY: A course of study in elementary science should be broad—not too many detailed units. These should be adapted to grade, age, and interest.

DR. CAHOON: These units interest me. Miss Burgess, did you

keep a record of the activities and the experiences with the hope that you would develop a unit on the things the children wanted? Did you find out if they would be interested in those things? What if they wanted to do something with plants instead of guinea pigs?

MISS BURGESS: There isn't any stereotyped thing that they do. They may hunt up experiments and the questions may suggest things for them to do. (All classes are not doing exactly the same thing.) However, there are a few basic understandings which all children have to learn.

DR. RUSSELL: The course of study is a very interesting phase of elementary science. You don't have to follow a course of study exactly, but you will find activities listed in a good course of study.

(FROM THE AUDIENCE): I think a course of study is more than just an outline. It guides the teacher along the way and helps her in preventing mistakes. Most courses of study contain bibliographies, which are helpful too.

DR. CAHOON: You would suggest, then, that a course of study be flexible in detail and in the units which are included. Now, I wonder about these units. How can you tell whether a unit is good or not? What about this?

DR. RUSSELL: In three words: (1) Interest, (2) Needs, and (3) Happiness.

DR. CAHOON: How do you get happiness in a unit?

DR. RUSSELL: You can't, unless the child has it. If he goes about his work and shows some interest and enthusiastic pleasure in it, the unit will be a happy one. I am sure you will agree that much more can be accomplished if the child is in a happy frame of mind.

DR. CAHOON: Happiness should be inherent in the unit. It goes along through the unit and throughout the whole relation between teacher and pupil.

MRS. HOWARD: Why not take happiness out of the unit and put it in the classroom?

DR. CAHOON: There you have a good point, Mrs. Howard.

MR. BUCKLEY: That unit ought to have enough basic material in it to keep the teacher from merely making a joyful noise into science.

MISS BURGESS: Dr. Cahoon, are you talking about the written unit or the unit as it develops in the classroom?

DR. CAHOON: Perhaps it would be well if we cleared up the

idea of what we mean by unit. How do we use the term "unit"?

MISS BURGESS: When we write up a unit, we keep in mind certain phases for making that unit useful to the teacher.

DR. CAHOON: Could you give us a specific example? Does it have a particular subject matter, activities, experiments, demonstrations, supplementary reading materials?

MISS BURGESS: In our Cleveland course of study in science, the basic problems are suggested and also any activities, experiences or projects that will help the children to answer these questions. These are explained in the language of the children. Basic understandings are included in all the units, as well as materials that may be required. There is a good bibliography for the teacher and for the children and also a list of visual aids that are helpful. It is quite complete and can be used by a beginning teacher, or an experienced teacher.

DR. CAHOON: Is there anyone else who has anything to say about this idea of a unit?

DR. RUSSELL: You hand out ideas in the original written unit. To me, the most valuable unit is the one written after the activities are over. There are certainly good suggestions in a unit written this way and it is also a curriculum record.

DR. CAHOON: Well, our time is nearly up and we have discussed only three of these possible topics that were suggested, so there still seem to be some questions which remain unanswered.

Here is a question which I should like to ask. Why should we have elementary science? What is the purpose of elementary science? I thought the elementary school was for reading, writing and arithmetic. Why should we bring in anything like elementary science?

MR. SHUMAN: Well, children become interested in the general fields of science as low as the Fourth Grade. If we do not stimulate this interest in the elementary school, by the time they reach high schools, they are no longer interested in science.

MR. BUCKLEY: When a little child of kindergarten age asks the question, "Who made God?" and other similar questions, he should not be told to "shut up," in order that we might learn just the three "R's." I would say that stimulation of interest is the basic problem. If you can keep the child interested and alive, you need not worry for fear he will not be interested in exact information later on.

DR. CAHOON: Does anyone else care to tell us why we should

have elementary science? Well, let us get back to the idea of these units. Should the elementary teacher select them, or should the principal, or should the superintendent?

MISS BURGESS: I should like to tell how the units in Cleveland were selected. The units were developed slowly. We hoped to find out what the children were most interested in. Of course, this was affected by the age of the child and his environment. The units were shifted around in several different grades. We wanted to find out where they fitted best. The units were tried out by teachers in other schools also, with different types of children and in different environments. These were then written up for our tentative course of study.

DR. CAHOON: It seems, then, that teachers should have some part in selecting the units.

DR. KAMBLY: In our school that is not such a great problem. If the unit has been used in a particular grade, the children start asking, "When are we going to do this?" "When are we going to do that?" They look forward to these particular units.

MR. SHUMAN: Should we not teach science according to the seasons? For instance, when the planets and stars are most clearly seen in the sky, should we not study astronomy then? Why not call attention to these things when they actually appear in the sky? You can adjust your science teaching to the particular unit you have at that time.

DR. CAHOON: It is just about time to bring this discussion to a close. Here is one other question that has been asked by someone in the audience which I think is a very good one. Can elementary science be well taught by a teacher who handles other subjects, or should the teacher be one who teaches science exclusively?

MR. BUCKLEY: I am one of those who believe that a school will not become a real organization so long as every room is like every other room or so long as there is no knowledge above the general level in any field. A music room ought to have the atmosphere of music when the children go into it. The child should be able to go to the library and find a certain atmosphere there. In the science room the same should be true. The equipment does not need to be elaborate or expensive, but certainly there should be a sufficiently rich body of material in the science room so that the very environment will raise questions in science.

DR. CAHOON: This would be perhaps a good place to stop

this discussion. We have at least tried to explain some of the questions if we have not actually solved them.

(From the audience): Suggestion that discussion continue.

Miss Melrose: That shows us how good this panel discussion has been. I suggest that those who wish to continue talking about these vital problems in Elementary Science, remain after the adjournment of the panel. We feel very grateful, indeed, to these members of the Round Table who have given us many interesting things to think about.

TEACHING MATHEMATICAL INDUCTION

B. Friedman

Wilson Junior College, Chicago, Illinois

There has been some discussion of Prof. Goodrich's article on "Teaching Mathematical Induction" in the May 1940 issue of School Science and Mathematics. Prof. Krathwohl, in the Jan. 1941 issue, remarked that Prof. Goodrich had committed a serious error in logic by advocating the following procedure:

To prove two expressions are identities, set them equal to each other, then perform identical operations on both members of the equation. If the equation reduces to an obvious identity then the original expressions were identities.

In his reply Prof. Goodrich claims that if an assumption is made and correct mathematical procedures are followed leading to a known truth, the assumption is proved true.

Both statements are correct. Logically it is wrong to assume a conclusion, derive a known truth from it and then claim that the conclusion is thereby proved. For example, assume all mortal beings are men. Socrates was a mortal being and therefore Socrates was a man. Obviously this argument does not justify our original assumption.

But mathematically it is correct to assume a conclusion and then by reversible (this is probably what Prof. Goodrich meant by correct) methods derive an identity. This is still not a proof but now the assumed conclusion can be proved, because starting with the final identity, all the steps can be reversed and thus the desired conclusion logically obtained.

In both logic and mathematics the proof is valid only if we start with correct premises and logically derive the required conclusion. However, in mathematics, the proof is usually omit-

ted since it can easily be obtained by reversing the steps of our analysis.

Nevertheless, it must be remembered that the reduction to an identity is not a proof. For how can we be sure that by a different method of reduction, we may not be led to a contradiction? A hypothesis needs only one contradiction to disprove it while an infinite number of verifications do not prove it.

A few examples will clarify this. Assume $1=2$. Then $2=1$. But since equals multiplied by equals are equal, $1\times 2=2\times 1$. This is is an obvious identity. But the steps are not reversible. Therefore it cannot be concluded that $1=2$.

Again assume

$$\sin\theta(\cos^2\theta+\sin^2\theta)+\cos\theta=\cos\theta(\cos^2\theta+\sin^2\theta)+\sin\theta \tag{1}$$

But if this is true, then

$$\sin\theta(\cos^2\theta+\sin^2\theta)-\sin\theta=\cos\theta(\cos^2\theta+\sin^2\theta)-\cos\theta \tag{2}$$

or

$$\sin\theta(\cos^2\theta+\sin^2\theta-1)=\cos\theta(\cos^2\theta+\sin^2\theta-1). \tag{3}$$

Dividing both sides by $\cos^2\theta+\sin^2\theta-1$,

$$\sin\theta=\cos\theta$$

which is not an identity. However the original equation is an identity since $\cos^2\theta+\sin^2\theta=1$ and $\sin\theta+\cos\theta=\cos\theta+\sin\theta$.

Many textbooks in proving trigonometric identities insist that only one side of the identity be transformed. The reason probably is to avoid irreversible operations. However with a little care this restriction can be removed.

For example, to prove

$$\frac{1-\sin\theta}{\cos\theta}=\frac{\cos\theta}{1+\sin\theta}\,.$$

Cross-multiplying, $1-\sin^2\theta=\cos^2\theta$ which is an identity.

This procedure is not a proof. But the steps can be rearranged.

$$1-\sin^2\theta=\cos^2\theta$$

or

$$(1-\sin\theta)(1+\sin\theta)=\cos\theta\cdot\cos\theta$$

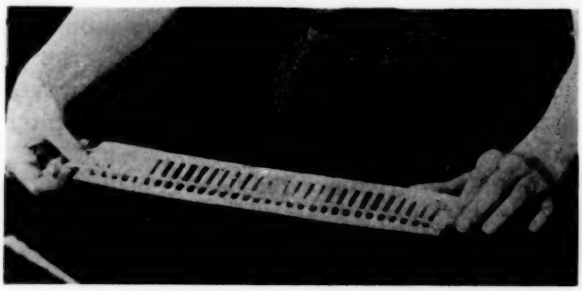
and dividing both sides by $(1+\sin\theta)\cos\theta$, the original identity is proved except when $(1+\sin\theta)\cos\theta=0$ in which case the division is impossible. In these cases the original equation is meaningless.

AN APPARATUS FOR ILLUSTRATING BEATS

William C. Shaw
Abraham Lincoln High School, Des Moines, Iowa

One of the most interesting sidelights to the study of sound in high school physics is the phenomenon of beats. The author in explaining this effect has often resorted to the familiar illustration of two picket fences running parallel to one another and viewed from the side.[1]

This illustration is none too easy to set up verbally and as often as not results only in added confusion in the minds of the students.



As an outgrowth of the enthusiastic efforts of some students, to whom the concept was clear, to explain it to others, it was proposed that as a project, an apparatus be devised to demonstrate the formation of beats.

Displaying a degree of ingenuity commonly shown in young people when confronted with the problem of making others understand that which it seems should be so clear, but is not, the device to be described was constructed.

A base consisting of about 1/16 inch sheet metal or $\frac{3}{8}$ inch hard wood measuring about 3×15 inches was used. After coating the base with white enamel a series of black $\frac{1}{4}$ inch stripes each about 2 inches long and $\frac{1}{4}$ inch apart were made transversely on the top surface.

One-quarter inch white strips were now needed having a

[1] At regular intervals, due to the greater visual angle of the spaces in the nearer fence, a patch is observed where the view beyond the fences may be seen through the coinciding spaces between pickets while at alternate intervals the coincidence of the spaces in one fence with the pickets in the other causes obliteration.

length slightly less than the width of the base. After considerable research the most satisfactory material was found to be celluloid colored white. To color celluloid white it is dipped in denatured alcohol and allowed to dry, repeating if necessary. These strips were attached to two bands of elastic using an ordinary paper stapling machine. The staples were caused to straddle the elastic thereby making it possible to forcibly adjust the position of each strip on the elastic bands.

The white strips were then spaced at a distance slightly less than $\frac{1}{4}$ inch and one pair of ends of the elastic was fastened near one end of the base. The other pair of ends was attached to a piece of doll pin which serves as a holder.

In use a preliminary explanation should be made pointing out that the white strips and stripes symbolize the compressions of two separate sound waves and the rarefactions are represented by the spaces in the lattice and the black stripes on the base.

The length of the base may stand for the series of waves emitted in, say, one second and the number of waves in this space corresponds of course to the frequency or pitch of the sounds.

To demonstrate interference the base is held with one hand while the other stretches the lattice of strips till they just cover the black stripes on the base showing destructive interference. Now to demonstrate constructive interference two fingers of the base holding hand are used to move the last strip back enough to cover a white stripe instead of a black. A corresponding slackening at the free end synchronizes all of the whites. This brings out clearly that instead of canceling one another the two sets now serve to reenforce one another.

The extension to beats is obvious. When the elastic lattice is stretched so that the number of strips within the length of the base is one less than the number of stripes a dramatic demonstration of one beat at the center portion of the base is made. Two, three, or four beats per second (remembering that the base may represent the waves emitted per second) are graphically shown by stretching the lattice further. This incidentally provides an excellent proof that the beat frequency equals the difference in frequency of the two sets of waves.

With but little preparation beyond the preliminary explanation of what is represented by this apparatus these phenomena are now made clear to even the slowest to understand. The extensions of the idea reach in several directions. When the view

through a window is seen through two screens, or a curtain and a screen, the two dimensional wave-like patterns, simulating the grain in wood and changing with the movements of the observer, are now seen to be but another application of beats.

When studying chords the beat notes formed by the simultaneous sounding of the notes of the major triad, C(256), E(320), G(384) were found by one student, a guitar player by the way, to have an octave relationship to C(256), the "root" of the chord. Since only advanced references mention this relationship this was, as can be imagined, a very exciting discovery for a high school student to make.

THE JOB AHEAD

John W. Studebaker, *U. S. Commissioner of Education*

At this time I am more convinced than ever that the men and women of our profession are indispensable in this crisis. Your aggressive leadership and quick action which have characterized the development of the training program to date are of vital importance. Our watchword must be *NOW!*

In the vocational training program we ought to be doing two things—NOW!

First, we must make our present training program hit its mark with efficiency. The reports are already bulging with evidence of success on this score.

Second, we should be making definite plans now for the expansion of this program.

Look at the record:

In Germany every employable person at work or in training . . . technical and vocational schools running at capacity in the captive countries . . . skilled workers being shipped into Germany.

England and France for a long time tried to carry on defense without total organization.

In the United States there are five or six million employable people out of work . . . most of these people need preparatory training or "refresher courses."

Conclusion: Either we are going to put these employables to work or we are not going to be equal to the threat we now face. If we are going to put them to work they must be trained. They must be started in training weeks and months before the factories are ready to put them to work or the factories, to an unwarranted extent, will mark time for want of skilled hands.

Nobody yet has a blueprint of the exact total needs of industry. Every one of us, with our local, regional and national experiences and contacts must be planning now how we can meet future demands with school-training facilities. Especially will local administrators and advisory committees consisting of representatives of labor and management know how to provide a balanced expansion of the program. But there must be expansion.

Be sure of this: We shall be much safer when all hands are trained and are at work.

SCIENCE TEACHERS SPEAK ON REQUIREMENTS

LEONARD A. FORD
State Teachers College, Mankato, Minnesota

What subject matter should be included in the preparation of a prospective high school science teacher? Should he be prepared to teach one science or all sciences? Should he be prepared to teach outside the field of science; if so, what subject or subjects?

Statistics on placement and teaching combinations obtained from the local placement bureau and other sources[1,2] indicate that science teachers should be prepared to teach all of the sciences and that mathematics is the most likely subject to be combined with science. This information does not indicate how broad or intensive the training should be. The science teachers themselves should be best qualified to know what constitutes a well rounded program in science and mathematics.

The author was appointed by the science teachers in the Minnesota State Teachers Colleges to investigate minimum requirements for science teachers. A questionnaire was prepared and answered in whole or in part by 52 science teachers. These teachers were science majors at college and were now teaching in the small high schools in Minnesota. The frequency of replies is indicated in the questionnaire.

September, 30, 1940

The science instructors of the State Teachers Colleges in Minnesota will meet this fall at the M.E.A. to discuss science offerings and requirements for science majors.

The prospective high school science teacher who graduates from the Minnesota State Teachers Colleges will likely obtain his first position in a small high school where he will be asked to teach junior high school science. He will likely have a class in either biology, chemistry or physics and some mathematics. Often a subject or two from other fields may be included in his program.

Your opinion in answer to the following questions will be highly appreciated. A self addressed envelope is included.

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[1] Potthoff, Edward F., "What Combinations of Subjects Constitute the Teaching Load of Secondary School Teachers?" *North Central Association Quarterly*, x (October, 1935), p. 241.

[2] Annual Catalog, 1940–1941, Central Missouri State Teachers College, Warrensburg, Missouri, p. 49.

1. Should the prospective science teacher be required to take (1) a divided major (some work in each of the fields: chemistry, physics and biology) or (2) work in only one field? (1) 51, (2) 1.
2. In the case of a divided major is one year's work in each of the three fields sufficient background in science? Yes 21, No 30.
3. If 2 above is answered no, should the prospective science teacher take (1) one, (2) two, or (3) three years additional in one of the fields? (1) 9, (2) 16, (3) 6.
4. In a divided major, should enough science be required in one field so that the prospective science teacher would be qualified to do graduate work in that field? Yes 39, No 6.
5. Of the 192 quarter hours to graduate from the Minnesota State Teachers Colleges, approximately how many hours should be devoted to science 66 (median) mathematics 24 (median)?
6. Should mathematics be required of a science major? Yes 44, No 5.
7. If 6 above is yes, should the mathematics extend through (1) algebra, (2) trigonometry, (3) analytic geometry, (4) calculus? (1) 6, (2) 17, (3) 14, (4) 10.
8. Is the survey or orientation course in science of sufficient value to be required of science majors? Yes 28, No 21.
9. Aside from practice teaching, science methods or other courses on science teaching, how many quarter hours in education should be a minimum? 12 (median).
10. What portion of the science training should be laboratory work? (1) $\frac{1}{2}$, (2) $\frac{1}{3}$, (3) $\frac{1}{4}$, (4) less than $\frac{1}{4}$. (1) 10, (2) 22, (3) 12, (4) —.
11. Any comments that you may make on the minimum requirements for science teaching would be appreciated. You may use the back of this sheet.

Your Name———————— Position————————

The questionnaire reveals that science teachers believe they need a wide background in the entire science field in addition to several years of work in one specialized science. There should be enough work in one science to enable the prospective teacher of science to do graduate work in that field.

Science teachers believe that approximately half of their undergraduate training (90 quarter hours) should be devoted to

science (66 quarter hours) and mathematics (24 quarter hours).

There seemed to be a diversity of opinion as to the value of the survey or orientation course for science majors. Outside of education work that had reference to science teaching, 12 hours in this field was considered sufficient.

The value of training in laboratory work was emphasized in question ten where teachers stated that one-third of the science training should be in this phase of science work.

In their comments science teachers stated that their undergraduate training contained an overemphasis of non-science subject matter. Required courses in education, music, art, and other fields received considerable criticism by these teachers who felt that their time could have been better directed by obtaining a wealth of information about science.

A LOW-COST SCIENCE EXHIBIT

Warren M. Davis
Steubenville High School, Steubenville, Ohio

In this age of popularization of science, teachers in the field are often called upon to prepare an exhibit which will present some phase or phases of their work. It would seem desirable and of great importance that in preparing such an exhibit, its educational implications for the participating individuals be taken into consideration. It is, in fact, quite in line with the philosophy of progressive education to look upon an exhibit as chiefly a way of educating the participants, and secondarily as a presentation of the work accomplished by the school.

The following idea for a display is based on the premise that an exhibit can be assembled which will be of true general interest while being highly useful in education and at the same time being so low in cost that it can be produced by the poorest school. Reference is made to an exhibit of materials useful in teaching science which are obtainable by any school free of charge.[1]

Chemistry classes taught by the writer have just completed such a display, prepared for the 1940 annual meeting of the Eastern Ohio Teachers' Association, and the response to the display was gratifying in the extreme. It was also viewed by a

[1] The writer has been greatly assisted in this work by Drs. Cahoon and Zirbes of Ohio State University, Dr. Croxton of Minnesota State Teachers College and Miss Margaret Graf of Akron, Ohio.

great body of non-school people, parents and visitors, who were guests at the school open house held the week following the association convention.

PLANNING THE EXHIBIT

In planning the exhibit, sources for free materials were carefully collected and analyzed as to the probable use of the materials available in a display dealing with science. These were obtained in various ways, many of them coming from certain indexes[2] and certain ones from local, state, state university and commercial sources gathered together by the writer and his students. Following a study of the sources for free materials which would very probably be of use, letters were written, chiefly by the students, to the various groups offering free materials dealing with science.

While the ground-work was being laid for the display, certain criteria for judging the material had been set up with the cooperation of the entire group, and upon arrival the exhibits were judged by the person making the request for the article, and pupil judgment was written on a small card attached to the exhibit material. Thus each display, chart, bulletin, or poster lent itself to the educative process of discriminative judgment according to certain standards, and each lent itself to pupil self-expression.

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[2] The following indexes and source books for free and low cost materials were used. Certain of these are low enough in price to be available to all.

A Bulletin of Free and Inexpensive Teaching Aids for Junior and Senior High Schools. Allegany County Public Schools, Cumberland, Maryland. 108 Washington St., Office of the Board of Education. Price 50¢.

Educator's Index of Free Materials. John Guy Fowlkes, Ph.D., Compiler. Publisher: Educators Progress League, Randolph, Wisconsin. Price upon request to company.

Enriched Teaching Series. Maxie Woodring and others New York: Columbia University Press. $1.75 per volume.

Free and Inexpensive Educational Materials. Quarrie Reference Library, 35 E. Wacker Drive, Chicago, Ill. 1937 Edition. Price $5.00.

Government Publications of Use to Teachers of Geography and Elementary Science. Washington: Office of Education, Department of Interior, Leaflet No. 31.

Handbook of Free and Inexpensive Materials. Bruce Miller, Publisher and Compiler, Ontario, California. 1940. Single copies, $1.00, in quantities of ten, 60¢ each.

Modern Methods and Materials for Teaching Science. Heiss, Obourn and Hoffman. MacMillan. New York. 1940.

Monthly Check List of State Publications. Supt. of Documents, Washington, D.C. Library of Congress. Price 15¢ per copy or $1.50 per year.

New Government Aids to Teachers. Feature of magazine "School Life."

References on Free and Inexpensive Aids for Classroom Use. National Education Association, 1940.

Standard Catalog for High School Libraries. H. W. Wilson Co. 475 University Ave., New York, N.Y. Sold on a service basis.

Supplementary and Free Social Study Material. Mable Snedaker. University of Iowa Extension Bulletin, Iowa City, Iowa. Price, 20¢.

Vertical File Service. H. W. Wilson Co., 475 University Ave., New York, N.Y. Sold on a service basis.

Approximately 350 letters were written and material of value was received from almost all of the sources contacted. Some of this was of such value in the field of science that it would be considered excellent teaching material even though its cost were relatively high. This is especially true in the area of synthetic chemistry where many valuable displays were obtained free.[3]

Displaying the Material

For purposes of display the material was divided into the various sciences with sections reserved for the following areas of the field: chemistry, conservation, elementary science and nature study, general science and mechanics, and safety and health. This type of organization seemed wise since the teachers, who were the most numerous group to view this particular exhibit were thus able to rather readily select their field of interest. In general the elementary teachers spent most time at the safety-health display, while secondary teachers seemed to take most notes at the display of chemical materials. It was found necessary to stress to almost all of the visitors that the entire display had been assembled without the expenditure of any money whatever except the cost of mailing letters or postal cards.

Approximately 450 persons, aside from school students, viewed the display, and many returned one or more times to see and take notes on materials which they desired for use in their own schools. Student help was used throughout in explaining the exhibit. The writer believes that the presentation of such a display can be made the occasion for furthering education in the ways already mentioned, and in addition because the materials remain in the school and may be used at any time in illustration of or enrichment for further work in science. There have been countless times since, when if by no more than a mention, the fact that the students have assembled, viewed and used the exhibit materials can be shown to have broadened their science experiences.

[3] Outstanding were the displays sent by the following groups:
Behr-Manning Corp.—Abrasives.
California and Hawaiian Sugar Refining Corp.—Steps in Refining Sugar.
Corning Glass Works.—Pyrex display
E. I. Du Pont de Nemours.—Synthetic display.
Electric Storage Battery Co.—Cut-away storage cell.
General Motors Corporation.—Charts, booklets.
International Silk Guild.—Silk display.
Permutit Co.—Model water softener.
Pittsburgh Plate Glass Co.—Plate glass display.

PROBLEM DEPARTMENT

Conducted by G. H. Jamison
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1685. *Leland S. Russell, McCloud, Calif.*
1676. *Frances Crook, Baie Comean, Quebec.*

PROBLEMS FOR SOLUTION

1687. *Proposed by D. L. MacKay, New York*

Determine an angle such that the sum of its six trigonometric functions equals a given quantity k.

Solution by Alvin Mars and Sanford Glassman, Brooklyn College

$$\sin\theta+\cos\theta+\tan\theta+\cot\theta+\sec\theta+\csc\theta=k \tag{1}$$

Reducing to sines and cosines,

$$\sin\theta+\cos\theta+\frac{\sin\theta}{\cos\theta}+\frac{\cos\theta}{\sin\theta}+\frac{1}{\cos\theta}+\frac{1}{\sin\theta}=k$$

Thus:
$$\sin\theta+\cos\theta+\frac{1}{\sin\theta\cos\theta}+\frac{\sin\theta+\cos\theta}{\sin\theta\cos\theta}=k \tag{2}$$

Since $\dfrac{1+\sin\theta+\cos\theta}{\sin\theta\cos\theta}=\dfrac{2}{\sin\theta+\cos\theta-1}$, (2) becomes

$$(\sin\theta+\cos\theta)\times\frac{2}{(\sin\theta+\cos\theta)-1}=k$$

Hence $$(\sin\theta+\cos\theta)^2-(1+k)(\sin\theta+\cos\theta)+k+2=0$$

thus $$\sin\theta+\cos\theta=\frac{(1+k)\pm\sqrt{k^2-2k-7}}{2}$$

Squaring both members and recalling that $(\sin\theta+\cos\theta)^2=1+\sin 2\theta$,

$$1+\sin 2\theta=\frac{(k^2-3)\pm(1+k)\sqrt{k^2-2k-7}}{2}$$

Thus $$\sin 2\theta=\tfrac{1}{2}(k^2-5)\pm\tfrac{1}{2}(1+k)\sqrt{k^2-2k-7}$$

Hence $$\theta=\tfrac{1}{2}\arcsin[\tfrac{1}{2}(k^2-5)\pm\tfrac{1}{2}(1+k)\sqrt{k^2-2k-7}]$$

This gives all values of θ that are a solution for a given k.

Other solutions were offered by David X. Gordon, Brooklyn N. Y.; Abraham I. Goodman, Brooklyn, N. Y.; Paul Overstreet, Wilmore, Ky.; C. E. Jenkins, Chicago; George Ross, Brooklyn, N. Y.

1688. *Proposed by C. W. Trigg, Los Angeles.*

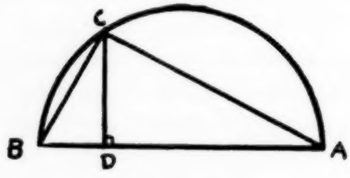
From a point C on the circle with diameter BA, a perpendicular CD is drawn to BA. Find angle B such that $BD=K\cdot CA$ and show that such an angle exists for all positive values of K. For what values of K will $\sin B$ be rational?

Solution by Aaron Buchman, Buffalo, N. Y.

It is easily shown that $BD=BA\cdot\cos^2B$ and $CA=BA\cdot\sin B$. Replacing these values in $BD=K\cdot CA$ and simplifying,

$$\sin^2B+K\sin B-1=0 \tag{1}$$

and $$\sin B=\frac{-K\pm\sqrt{K^2+4}}{2} \tag{2}$$



From (2), the roots are real for all real values of K. From (1), since the product of the roots is -1, one of these real roots must be less than or equal to one. Thus, for all values of K, (real), $\sin B$ exists, and therefore angle B exists.

It is at once seen that $K=0$ is the only integer which will make $\sin B$ rational.

To find other fractional values of K which will make $\sin B$ rational, the equations for an integral Pythagorean triangle may be used. These are $x=r^2-s^2$, $y=2rs$, $z=r^2+s^2$ (see any book on theory of numbers). From

them it is easy to derive the condition, $K = \dfrac{r^2-s^2}{rs}$, where r and s are *any* relatively prime integers.

Solutions were also offered by George Ross, Brooklyn, N. Y.; D. L. MacKay, New York, N. Y.; David X. Gordon, Brooklyn, N. Y.; Frances Crook, Baie Comean, and the proposer.

1689. *Proposed by Frederic E. Nemmers, University of Iowa.*

Solve for x: $\sqrt[3]{6x+28}-\sqrt[3]{6x-28}=2$.

First solution by W. F. Crawl, Atlanta, Ga.

Transposing $-\sqrt[3]{6x-28}$ to right member, cubing the equation, and simplifying, we get $(6x-28)^{2/3}+2(6x-28)^{1/3}-8=0$, which has the quadratic form and can be solved by factoring,

$$[(6x-28)^{1/3}+4][(6x-28)^{1/3}-2]=0.$$

Setting each factor separately to zero and solving,

$$x=\pm 6$$

Second solution by the proposer

Using the relation: If $a+b+c=0$, then $a^3+b^3+c^3=3abc$.

$$\begin{aligned}(6x+28)-(6x-28)-8&=3\sqrt[3]{(6x+28)(6x-28)8}\\ 48&=6\sqrt[3]{36x^2-784}\\ 512&=36x^2-784\\ 36x^2&=1296\\ x&=\pm 6\end{aligned}$$

Other solutions were also offered by A. E. Gault; Alan Wayne, New York, N. Y.; George J. Ross, Brooklyn, N. Y.; John P. Hoyt, Cornwall, N. Y.; David X. Gordon, Brooklyn, N. Y.; H. Lazott, Worcester, Massachusetts; M. Kirk, West Chester, Pa.; Martha Hoagland, Geneva, N. Y.; Leland S. Russell, M'Cloud, California; Walter R. Warne, Rochester, N. Y.; Paul C. Overstreet, Wilmore, Ky.; Felix John, Pittsburgh, Pa.; Antonio Tudeno, Lakemont, N. Y.; Abraham I. Goodman, Brooklyn, N. Y.; Alvin Mars and Sanford Glassman, Brooklyn College.

1690. *Proposed by D. L. MacKay, New York*

Solve $x^4-x^2(2x-3)=2x+3$

Solution by Alvin Mars and Sanford Glassman, Brooklyn College

Transposing, we have: $x^4-2x^3+3x^2-2x-3=0$

This is equivalent to: $(x^2-x)^2+2(x^2-x)-3=0$, a quadratic in (x^2-x).

Factoring, $(x^2-x+3)(x^2-x-1)=0$.

Thus the roots of the original quartic are the roots of the two quadratic equations,

$$x^2-x+3=0 \text{ and } x^2-x-1=0.$$

Hence

$$x=\frac{1\pm\sqrt{5}}{2}\ \frac{1\pm\sqrt{11}i}{2}.$$

Other solutions were offered by: Grace Hicks, Fairport, N. Y.; Abraham Goodman, Brooklyn, N. Y.; H. Lazott, Worcester, Massachusetts; C. E. Jenkins, Chicago, Ill; D. L. MacKay, New York, N. Y.; David X. Gordon, Brooklyn, N. Y.; C. F. Holmes, Washington, D. C. Marcellus M. Dreiling, Collegeville, Ind.; Walter R. Warne, Rochester N. Y.; Rebecca Twining, Seneca, Co., N. Y.; Leland Russell McCloud, California; Felix John, Pittsburgh, Pa.; George J. Ross, Brooklyn, N. Y.

1691. *Proposed by D. L. MacKay, New York, N. Y.*

Solve: Tan (cot x) = cot (tan x)

Solution by the proposer

tan (cot x) = cot (tan x)
tan (cot x) = tan ($\pi/2 - \tan x$)
$\therefore$ cot $x = \pi/2 - \tan x$
cot $x + \tan x = \pi/2 + k\pi$, k and integer

$$\frac{1}{2\sin x\cos x} = \pi/2 + k\pi = \frac{\pi(1+2k)}{4}$$

$$\sin 2x = \frac{4}{(2k+1)\pi}.$$

Hence $x = \frac{1}{2}$ arc sin $\dfrac{4}{(2k+1)\pi}$.

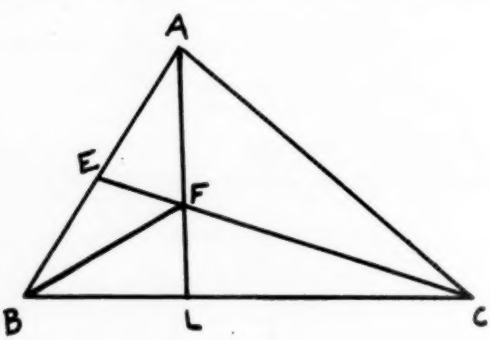
Solutions were also offered by Frances Crook, Bail Comean; Paul C. Overstreet, Wilmore, Ky.; David X. Gordon, Brooklyn, N. Y.; George J. Ross, Brooklyn, N. Y.; John P. Hoty, Cornwall, N. Y.; Alvin Mars and Sanford Glassman, Brooklyn College.

1692. *Proposed by Walter R. Warne, Rochester, N. Y.*

If E is the mid point of AB of triangle ABC and if AL is perpendicular to BC cutting CE in F, show that

$$AF = \frac{ab\sin C}{a + b\cos C}$$

Solution by C. E. Jenkins, Foreman High, Chicago, Ill.



Draw BF
$\triangle ABF = \frac{1}{2}\, AF \times BL$
Since EC is a median, $\triangle BFC = \triangle AFC = \frac{1}{2} AF \times LC$
$\triangle ABF + 2\triangle BFC = \triangle ABC$
$\frac{1}{2} AF \times BL + AF \times LC = \frac{1}{2} A \times AL.$
$AF \times BL + 2AF \times LC = a \times AL$

$$\therefore AF = \frac{aAL}{BL+LC+LC} = \frac{aAL}{a+LC} = \frac{ab \sin C}{a+b \cos C}$$

Solutions were also offered by George J. Ross, Brooklyn, N. Y.; D. L. MacKay, N. Y.; Walter R. Warne, Rochester, N. Y.; John P. Hoyt, Cornwall, N. Y.; M. Kirk, West Chester Pa.; David X. Gordon, Brooklyn, N. Y.; Alvin Mars and Sanford Glassman, Brooklyn College; Milton Brooks Philadelphia Pa.; Abraham I. Goodman, Brooklyn, N. Y.; Grace Hicks, Fairport, N. Y.; Wisner Kinne, Kenedaia N. Y.; Edward Hunt, Romulus, N. Y.; Elisha Reeves, Lodi Center, N. Y.; Carl Botdlander, Rutherford, N. J.; Felix John and C. F. Holmes, Washington, D. C.

STUDENT HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted to this department. Teachers are urged to report to the Editor such solutions.

1676, 81. *V. Muska and R. V. Smith, upper Canada (Toronto) College*
1679. *V. Muska*
1691. *Morris Greenfield, Los Angeles, City College*
1689, 90. *Joseph Diamond, New Attrecht High, Brooklyn, N. Y.*
1690. *Eva Dene Riley, Sturgeon, Mo.*

1705. *Proposed by Felix John, Pittsburgh, Pa.*

Find the prime factors of:

$$16x^4+81y^8+256z^{12}-72x^2y^4-288y^4z^6-128x^2z^6.$$

1706. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Fixed points B and C are on the sides of a fixed angle A. From a variable point P, PB and PC are drawn. PB cuts AC at D and PC cuts AB at E so that $CD = BE$ where CD and BE are measured from C and B in opposite directions with respect to A. Find the locus of point P.

1707. *Proposed by E. Ray Hancy, Hayts Corners, New York*

Show that x cannot be real in $\tan^3 x = \tan(x-A)$ if $\sin A > 1/3$.

1708. *Proposed by Alvan Saxton, Watkins, New York.*

Show that the sum of the squares of the distances of the center of the inscribed circle of triangle ABC to A, B and C is $ac+bc+ab-(6abc/a+b+c)$.

1709. *Proposed by Jerry Messler, Key West, Florida*

Solve (Completely):

$$x^{3/2}+y^{2/3}=3x$$
$$x^{1/2}+y^{1/3}=x$$

1710. *Proposed by Arthur Brooks, Ledger, New York*

Prove that there is only one set of real values of x, y, z, which satisfy the equation:

$$(1-x)^2+(x-y)^2+(y-z)^2=1/4$$

SCIENCE QUESTIONS

March, 1941

Conducted by Franklin T. Jones,
10109 Wilbur Avenue, S.E., Cleveland, Ohio

Contributions are desired from teachers, pupils, classes and general readers. Examination papers, questions on any part of the field of science, tests, anything that appeals to the reader or might appeal to other readers. Select your own topic. It will, very likely, be interesting to others.

Contributors to SCIENCE QUESTIONS are accepted, as their contributions are accepted, into the GQRA (Guild of Question Raisers and Answerers).

Classes and teachers are invited to join with others (more than 360 different contributors since October, 1934) in this co-operative venture in science.

INTEREST RAISERS IN ELEMENTARY SCIENCE

"Interest Raisers" first appeared in January 1941, SS&M. The first set of five questions came through Miss Anna E. Burgess, Principal of Miles Standish School, Cleveland, from boys and girls of the Fourth, Fifth and Sixth Grades of Doan School, Cleveland (Elected to the GQRA No. 356).

Answers were contributed by Miss Edna Byrne and boys and girls from Doan School, Cleveland. They were published in February, 1941. (This class and teacher were elected to the GQRA, No. 361).

"Interest Raisers" Nos. 6 to 10 were contributed by Miss Dorothy C Bliesch of Almira School, Cleveland, and a 6B Class, published in February, 1941 (Elected to the GQRA, No. 358).

ANSWERS TO INTEREST RAISERS 6 TO 10

Contributed by Miss Dorothy Bliesch and 6A Class, Almira School, Cleveland (Elected to the GQRA No. 362).

First are given individual answers by members of the class. Then the composite of answers by the class.

INDIVIDUAL ANSWERS—

6. *Answer by Earl Toth.*

"Can a balloon keep going up forever?

No, it cannot because:

(1) A gas balloon rises only in air and, when there is no air, it cannot rise.

(2) Also, when the air pressure outside the balloon is equal to that inside, it will not rise."

7. *Answer by Carol Scholtz.*

Could you take The Yankee Clipper to the moon?

"No, because the air pressure would become so light that The Yankee Clipper could not stay up and so it could not reach the moon."

8. *Answer by Shirley Salzer.*

How hot will boiling water get if we turn on more gas?

"The boiling point of water is 212 degrees. If the water is boiling, it cannot get any hotter; but it will evaporate."

9. *Answer by Joseph E. Titsch.*

"Can a cloud burst?

"No, a cloud cannot burst because it is water vapor. However it can develop into water. When a cloud comes into a colder area of air, the cloud develops into water. Then people say they have a cloud burst which is heavy rain."

10. *Answer by Betty Lou Hanover.*

Name one animal that would drown in water when full grown but would drown in air when young.

"Amphibians can drown on land when young and drown in water when adults because:

(1) When amphibians are hatched, they are hatched with gills to breathe the oxygen from the water.

(2) As the young amphibian grows older, it develops lungs. When they are developed, the amphibian lives on land."

Answer by Sally Hagan.

"The name of the animal is a frog.

"Tadpoles would drown in air because they have gills with which they breathe the oxygen from the water. And the frog would drown in the water because it has lungs with which it breathes the oxygen from the air."

Answers by the class as a whole.

6. Air gets thinner as altitude increases. The balloon will rise until inside pressure of the gas in the balloon and outside pressure of the atmosphere are equal, or until the gas in the balloon and the amount of the displaced air are equal in weight.

7. No. An airplane propeller "screws" its way through the air. The wings are held up by the air so long as the plane is moving. There is no air out in space, therefore we can't take The Yankee Clipper to the moon.

8. Water boils at 212°. It can not get any hotter but it will become water vapor or steam and disappear in the air.

9. A cloud cannot burst because it is not a sack or a bag. It is an accumulation of water vapor. When the vapor condenses and we have a heavy rain, some people say we have a cloud burst.

10. Amphibians can drown in water when fullgrown because, when fullgrown, they have lungs. They would drown in air when young because, when young, they breathe with gills. Their gills disappear and lungs develop as they grow to maturity.

INTEREST RAISERS—NEW QUESTIONS, NOS. 11 TO 15

Proposed by Boys and Girls in the Fourth, Fifth and Sixth Grades at Doan School, Cleveland, Miss Irene VanChestein, Teacher. (*Elected to the GQRA, No. 363.*)

11. What causes an echo?
12. Why do we see lightning before we hear the thunder?
13. If a balloon is blown up in a warm room, and then taken out into the cold, would it get larger or smaller? Why?
14. Why can you see your breath on a cold day and not on a warm day?
15. How can a fish stay under water so long and people cannot?

Please try these questions on a class whether of the same age as the pupils who proposed them or of some other age. If you like, send some of the original papers of the pupils answering, either from one pupil for the entire list or separate questions and answers from individuals.

You are invited to get your classes to submit sets of questions in this series of

INTEREST RAISERS IN ELEMENTARY SCIENCE

For the convenience of those who do not have a January or February number of SCHOOL SCIENCE AND MATHEMATICS *at hand*

INTEREST RAISERS, Nos. 1 to 5, are repeated below.

1. Do all clouds give rain?
2. Why isn't the earth overrun with plants and animals?
3. Why don't all birds migrate?
4. Why is the beaver called one of our first conservationists?
5. If a comet's tail touches the earth, could we gather any pieces from it?

SOME ANSWERS

Correction by L. C. Fender (GQRA, No. 355).

"An error has been made in printing the Clausius-Clapeyron equation in answering SCIENCE QUESTION, No. 898.

The equation should read:

$$2.303 \log \frac{P_2}{P_1} = \frac{\Delta Hm}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right).$$

How fast can a honey bee travel?

905. How many miles can a honey bee fly in a hour?

LIFE, October 14, 1940, page 60, says "about a mile in 14 minutes. (Honey bees do not fly an hour at a time anyway. Read the entire article in *LIFE*, pp. 59–62. You will then be ready to "line a bee" and maybe find a "bee-tree.")

ANSWERS TO SOME QUESTIONS ABOUT MACHINE TOOLS

116. Six machine tools are the lathe, grinder, planer, milling machine, turret lathe, gear cutter.
117. Hoke blocks are standards of measurement (page 86, *LIFE*, Dec. 2, 1940).

(Answers for 118–119–120 will be published in April)

DO YOU KNOW THE ANSWERS?

(*If you don't, take a look in February, 1941, READER'S DIGEST*) *I thought of these questions as I went along reading a literary magazine and found all these references to scientific subjects.*

Are you educated if you don't know science?

126. "Encouragement is oxygen to the soul." What is scientific about that?
127. "Had not the leading scientists—among them Simon Newcomb, famous astronomer and mathematician—already explained with unassailable logic that the thing was impossible?"
What was the "thing"?

128. Who telegraphed—"What hath God wrought"?
129. Is malaria transmitted only by mosquitoes?
130. What is the theory of the lie detector?

Readers are requested to propose any sets of five questions that they think might be interesting or useful to others. Please make them as brief as possible. It will help to supply the answers.

LOGICAL THINKING

913. Why was Professor Simon Newcomb fooled as to the possibility of flight by a mechanical device?

914. Section A of the American Assn. for the Advancement of Science (Mathematics), met with the Assn. of Symbolic Logic at the Philadelphia Meeting of the AAAS.

In the *Paper Panel* on SOME DESIRABLE CURRICULUM ADJUSTMENTS IN SCIENCE AND MATHEMATICS (SCHOOL SCIENCE & MATHEMATICS, February, 1941, page 106). Mr. Walter H. Carnahan, Shortridge HS, Indianapolis, asked Mr. Joseph A. Nyberg, Mathematics, Hyde Park HS, Chicago, the question—"*Mr. Nyberg, where and how in our high school curriculum can we provide for adequate experience in correct logical thinking?*"

Mr. Nyberg answered in part—"We still have not done our duty to the pupil unless we devote some time to discussing some of the *typical errors in reasoning*. . . . Such topics as *ad hominen reasoning*, *reasoning in a circle*, *faulty analogies*, *poor authorities*, *non-causal relations*, *assuming a converse*, *avoiding the question*, *appeals to prejudice*, and the *technique of propaganda*." . . . "We cannot expect the English, or Latin, or Chemistry teacher to include them in their courses; The Geometry teacher must do the work."

How might Miss McAtee (Science, Hammond, Ind.), or Mr. Ira C. Davis (Science, University High School, Madison, Wis.), have answered the question?

915. Do we need a course in Logical Thinking in our high schools and colleges? Should it be a required course?

916. Are we, as teachers of science and mathematics, permitting our proper function as teachers of practical logical thinking and experiment, to be taken by subjects and the teaching of subjects in which the methods of propaganda are as likely to be used as correct logical thinking?

These questions are something to think about!!!

NO ANSWERS TO "A WAR PROBLEM," No. 909

Answers will be appreciated, or comments. The newspapers have criticized German schools for using "bombing problems."

SOME DATA ON A FALLING BOMB

917. *Supplied by Edward B. Cooper (GQRA, No. 254), Brookline HS, Brookline, Mass.*

"I am enclosing some data on an actual falling bomb which may furnish some food for thought by someone. I understand it was taken photographically on a falling bomb although the exact source of the data is not in my records."

Time since bomb started falling	Distance fallen	Time since bomb started falling	Distance fallen
1 second	16 feet	11 seconds	1812 feet
2 seconds	64 "	12 "	2268 "
3 "	144 "	13 "	2652 "
4 "	256 "	14 "	3064 "
5 "	400 "	15 "	3502 "
6 "	576 "	16 "	3965 "
7 "	782 "	17 "	4453 "
8 "	1019 "	18 "	4965 "
9 "	1287 "	19 "	5499 "
10 "	1585		

STUDENT QUESTIONS

918. *Supplied by Arthur O. Baker, John Marshall High School, Cleveland (Elected to the GQRA, No. 364).*

Student Questions on Light used Prior to the Teaching of the Unit
(11A Physics—Science Curriculum Center)

Pupil #1

1. Is the light from the stars generated or reflected?
2. What is the heat of the sun?
3. If it takes 8 minutes for the light of the sun to reach us, how long does an eclipse block out the light before we see it?
4. Theoretically, when the sun passes beyond the horizon, how long does it continue to shine in your presence?
5. What is the diameter of the sun?
6. Is light from the moon reflected from the sun? If so, how long does light take to travel from the sun to the moon to the earth?

Pupil #2

1. I would like to know more about the refractions and reflections of light.
2. I would like to know more about concave and convex mirrors, and concave and convex lenses.

Pupil #3

1. Why does light travel so fast?
2. Will the sun ever lose all its lighting power?

Pupil #4

1. Explain the use of infra-red light in photography.
2. Explain, if possible, the reason or cause for effect on germs of ultra-violet lights.

Pupil #5

1. What is a shooting star, and does it really fall when we see it, or many years before?
2. What is the difference between a planet and a star?
3. What is light?
4. Where does it originate?
5. Why are the days longer in the summer and shorter in the winter?
6. What is the sun composed of?
7. What percentage of our light do we get from the stars and the moon?
8. Why can't we see the stars in the day time?

Just in case you don't already know: if all the people the railroads carry in

a year were seated on the opposite sides of a dining table, they could reach across the table!!! (Answer as promised.)

GQRA—NEW MEMBERS, MARCH, 1941

362. Elementary Science Class, 6A, Almira School, Cleveland, Miss Dorothy C. Bliesch, Teacher.
363. Elementary Science Class, Doan School, Cleveland, Miss Irene Van-Chestein, Teacher.
364. Arthur O. Baker, Science, John Marshall HS, Cleveland.

JOIN THE GQRA!!!

BOOKS AND PAMPHLETS RECEIVED

College Algebra, by N. J. Lennes, *Professor of Mathematics, University of Montana.* Revised Edition. Cloth. Pages xii+432. 13×20.5 cm. 1940. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $2.25.

Unresting Cells, by R. W. Gerard, *Associate Professor of Physiology, University of Chicago.* Cloth. Pages xv+439. 14×21.5 cm. 1940. Harper and Brothers, 49 East 33rd Street, New York, N. Y. Price $3.00.

Practical Mathematics, Part III, Geometry with Applications, by Claude Irwin Palmer, *Late Professor of Mathematics and Dean of Students, Armour Institute of Technology, Chicago, and* Samuel Fletcher Bibb, *Associate Professor of Mathematics, Illinois Institute of Technology, Armour College of Engineering, Chicago.* Fourth Edition. Cloth. Pages xii+206. 11.5×17.5 cm. 1941. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N. Y. Price $1.25.

Elements of Calculus, by Abraham Cohen, *Professor Emeritus of Mathematics, The Johns Hopkins University.* Cloth. Pages v+583. 13.5×20 cm. 1940. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $3.50.

A Study-Book for Everyday Problems in Science, by Wilbur L. Beauchamp, *University of Chicago;* John C. Mayfield, *University High School, Chicago;* and Joe Young West, *Maryland State Teachers College, Towson, Md.* Third Edition. Paper. Pages vi+346. 1940. Scott, Foresman and Company, 623 South Wabash Avenue, Chicago, Ill. Price 84 cents.

Hygiene, A Textbook for College Students on Physical and Mental Health from Personal and Public Aspects, by Florence L. Meredith, *Fellow of American Medical Association, American Public Health Association, American Psychiatric Association, Professor of Hygiene, Tufts College.* Third Edition. Cloth. Pages xii+822. 15×23 cm. 1941. The Blakiston Company, 1012 Walnut Street, Philadelphia, Pa. Price $3.50.

Ramanujan, by G. H. Hardy, *Sadleirian Professor of Pure Mathematics in the University of Cambridge.* Cloth. 236 pages. 17×26 cm. 1940. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $6.00.

First Principles of Chemistry, by Raymond B. Brownlee, *Stuyvesant*

High School; Robert W. Fuller, *Stuyvesant High School;* William J. Hancock, *Erasmus Hall High School;* Michael D. Sohon, *Morris High School;* and Jesse E. Whitsit, *De Witt Clinton High School, all of New York City.* Cloth. Pages xi+774+24. 14×29 cm. 1940. Allyn and Bacon, Chicago, Ill.

THE PYTHAGOREAN PROPOSITION, by Elisha S. Loomis, *Professor Emeritus of Mathematics, Baldwin-Wallace College.* Second Edition. Cloth. Pages xvi+284. 14.5×23 cm. 1940.

MODERN-LIFE CHEMISTRY, by Frank O. Kruh, *Summit High School, Summit, New Jersey;* Robert H. Carleton, *Summit High School, Summit, New Jersey;* and Floyd F. Carpenter, *Stivers High School, Dayton, Ohio.* Edited by W. H. Teeters, Supervisor of Physical and Biological Sciences, St. Louis Public Schools, St. Louis, Missouri. Cloth. Pages xxv+774. 13×20 cm. 1941. J. B. Lippincott Company, 333 West Lake Street, Chicago, Ill. Price $1.80.

MODERN TREND GEOMETRY, by William W. Strader and Lawrence D. Rhoads, *William L. Dickinson High School, Jersey City, New Jersey.* Cloth. Pages xi+444. 12.5×18.5 cm. 1940. The John C. Winston Company, Philadelphia, Pa. Price $1.48.

PLANE GEOMETRY, by F. Eugene Seymour, *Supervisor of Mathematics, New York State Department of Education, Albany, N. Y.*, and Paul James Smith, *Head of Department of Mathematics, East High School, Rochester, N. Y.* Cloth. Pages xi+467. 13.5×21.5 cm. 1941. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.60.

PLANE GEOMETRY, by Howard B. Kingsbury, *Chairman, Mathematics Department, West Division High School, Milwaukee, Wisconsin,* and R. R. Wallace, *Administrative Assistant, Wells High School, Chicago, Illinois.* Cloth. Pages xi+484. 13.5×21 cm. 1941. The Bruce Publishing Company, Milwaukee, Wis. Price $1.68.

NATURE SMILES IN VERSE, A COLLECTION OF BI-ILLOGICAL POEMS. Compiled by Bernal R. Weimer, *Professor of Biology, Bethany College, West Virginia.* Cloth. Pages x+99. 15×23 cm. 1940. Price $1.50.

FUNDAMENTAL MATHEMATICS, by Duncan Harkin, *Instructor in Mathematics, Brooklyn College, Brooklyn, New York.* Cloth. Pages xv+434. 14.5×23 cm. 1941. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $3.00.

GEOMETRY FOR TODAY, BASED ON A JUNIOR GEOMETRY BY A. W. SIDDONS AND R. T. HUGHES, by Alexander J. Cook, *Associate Professor of Mathematics, University of Alberta.* Cloth. Pages x+260. 12.5×19 cm. 1940. The Macmillan Company of Canada, Limited, St. Martin's House, 70 Bond Street, Toronto, Canada. Price $1.00.

THE OPINONS OF SCIENCE TEACHERS ON SOME SOCIALLY SIGNIFICANT ISSUES, by R. Will Burnett, *Research Associate, Bureau of Educational Research in Science, Teachers College, Columbia University, New York.* Paper. 55+8 pages. 21.5×27.5 cm. 1940. Professor R. Will Burnett, Teachers College, Columbia University, New York, N. Y.

THE HIGH-SCHOOL SCIENCE LIBRARY FOR 1939–1940, by Hanor A. Webb, *Editor of Current Science, George Peabody College for Teachers, Nashville, Tennessee.* Paper. Reprinted from Peabody Journal of Education, Vol. 18, No. 3, November 1940. 16 pages. 16.5×24 cm. Price 15 cents.

FUNDAMENTAL ECONOMIC ISSUES IN NATIONAL DEFENSE, by Harold G. Moulton. Paper. 32 pages. 13.5×20.5 cm. 1941. The Brookings Institution, Washington, D. C. Price 25 cents.

THE COMMISSION ON TEACHER EDUCATION, A Brief Statement of Its Origin and Scope. Paper. 18 pages. 15×22 cm. 1940. Commission on Teacher Education, 744 Jackson Place, N. W., Washington, D. C.

THE CONSERVATION CORPS. Paper. 23 pages. 15×23 cm. The American Youth Commission, Floyd W. Reeves, Director, 744 Jackson Place, Washington, D. C.

BOOK REVIEWS

A DIAGNOSTIC STUDY OF STUDENT DIFFICULTIES IN GENERAL MATHEMATICS IN FIRST YEAR COLLEGE WORK, by Elizabeth Boyd, Ph. D., *Teachers College, Columbia University*. Contributions to Education. No. 798. Cloth 152 pages. 15×23 cm. 1940. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $1.85.

This book presents the result of a study based on objective tests given to students in a course in general mathematics in Hunter College, the women's college of the City of New York. The text used was *General Mathematics* written by the Mathematics Department of Hunter College. In this text there are nine chapters dealing with such topics as trigonometry, coordinates, analytic geometry, tangents to curves, and the function and its derivatives. The course is offered students who are neither majors nor minors in mathematics nor majors in physics, chemistry, and business, and who have completed algebra, elementary and intermediate, and plane geometry in high school. It is presented in a time limit equivalent to 45 lessons of fifty minutes each.

The purpose of the twenty ten-minute tests was to determine various types of errors. These errors are classified under the following headings: Incorrect reading, Faulty expression, Misunderstanding or misuse of symbolism, Manipulation and use of tables, Visualization of geometric situations and relationships, Algebraic relationships, Selection of significant elements, Method of attack, and organization of resources.

The results of the tests were used in reteaching and retesting.

It is the opinion of the reviewer that the book deserves a careful reading by every teacher of college freshman mathematics.

J. M. KINNEY

THE PYTHAGOREAN PROPOSITION, by Elisha S. Loomis, Ph. D., LL.B., *Professor Emeritus, Baldwin-Wallace College*. Second edition. 16×23.5 cm. Cloth. 1940.

This book is a revision of the edition which appeared in 1927. In the first edition 230 proofs of the Theorem of Pythagoras were included. In the present edition we find 370 proofs.

The proofs are listed under four general types; namely, algebraic, geometric, quaternionic, and dynamic. Algebraic proofs are sub-divided into seven types, and geometric, into ten types. By means of these classifications and the use of the figures, it is easy to determine whether or not a supposedly new proof is new.

This book should be in the library of every high school and college.

J. M. KINNEY

PLANE AND SPHERICAL TRIGONOMETRY, by L. M. Kells, Ph. D., *Associate Professor of Mathematics, United States Naval Academy;* W. F. Kern, *Assistant Professor of Mathematics, United States Naval Academy;* and J. R. Bland, *Associate Professor of Mathematics, United States Naval Academy.* Second edition. Cloth. Pages xiv+401, 22×15 cm. 1940. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y. Price $2.00.

This second edition contains more problems than did the first edition and employs a psychological approach to each new topic. The many diagrams and picture drawings should give the student an understanding of the practical applications of trigonometry.

In the first two chapters are given the definitions of the trigonometric ratios of acute angles, the reciprocal functions, the complementary functions, the Pythagorean functions, identities and conditional equations.

Chapter III presents the general definitions of the trigonometric functions, the ratios for special angles and the supplementary functions. The other topics follow in the usual order but there are added chapters on the slide rule, astronomical applications of trigonometry, the mil, the range finder, the stereographic projection. Answers are included. There are no tables except for one page of the trigonometric ratios to degrees only and one illustrative page for degrees and seconds.

The complete and well-arranged plans of calculation for the solution of oblique triangles are outstanding and slide rule settings are given for each type of calculation.

This text will be more helpful to students of navigation and aviation than are most texts in trigonometry.

EDNA FELTGES
Woodrow Wilson Junior College, Chicago

MATHEMATICS INSTRUCTION IN THE UNIVERSITY HIGH SCHOOL, by Members of the Department of Mathematics of the University High School of the University of Chicago. Number 8, November 1940. Paper. Pages vii+184. 14.5×23 cm. The University of Chicago, Price $1.00.

This description of the curriculum in mathematics treats not only of the curriculum as it is now but reviews the changes that have been made in the last thirty-five years. It is therefor a review of the professional work of Ernest Breslich since 1904. The chapters discuss the aims of teaching mathematics in the University High School, the attempts at correlation with other high school subjects, the present units of intruction in grades seven to twelve, the teaching procedures, and the testing program. In addition, there are chapters on special istruction in arithmetic and the program for the enrichment of the courses. To those who are interested in history, the volume presents a record of the growth of correlation. To all teachers two of the chapters are particularly significant: one, which illustrates in detail the teaching of the unit on quadrilaterals in a geometry class, and the unit on simultaneous equations in an algebra class, and the last chapter which deals with the relation of mathematics to other fields such as the social sciences and the fine arts. Here are twenty pages of examples for the study of mathematics such as teachers are constantly seeking.

It is not often that the work of one man is so closely tied to the work of one school for so long a time. Prof. Breslich's work is a great contribution not only to the University High School but to all the schools of the country.

JOSEPH A. NYBERG
Hyde Park High School

ROUND THE WORLD IN INDUSTRY, by Gerald Collins. Cloth. Pages xi+180. 13.5×22 cm. 1940. The Chemical Publishing Company, Inc., 148 Lafayette Street, New York, N. Y. Price $2.00.

Round the World in Industry is a series of thrilling stories about sixteen occupations. The author has selected topics filled with adventure, daring, bravery, endurance, and skill. He is an adept at playing up the spectacular while portraying a true picture of actual working conditions in each industry. The book is highly entertaining and instructive, and is worthy of a place in any library. Some of the occupations covered are seal hunting cattle raising, deep-sea diving, airplane testing, lumbering, tunneling, and coal mining.

G. W. W.

TIME AND ITS RECKONING, by R. Barnard Way and Noël D. Green. Cloth. Pages viii+137. 13.5×21.5 cm. 1940. The Chemical Publishing Company, Inc., 148 Lafayette Street, New York, N. Y. Price $2.00.

How to count time is a topic of interest to people of all ages and stations. This little book was written for the general reader and requires no scientific background. The author first gives the astronomical basis for reckoning time and the historical development of time units and the calendar. Progress in time-keeping is described starting with the earliest forms of shadow clocks and sun dials, then through the period of water clocks to the time of Galileo and Huyghens when the pendulum was first used to control clock movements. Another chapter shows the improvements made to compensate for temperature changes, changes in spring tension, and bearing wear. Another describes some unusual time pieces, and still another the development of electric clocks. The author closes with an explanation of the system of time for all the world and some comments on the nature of time.

G. W. W.

NATURE RECREATION, by William Gould Vinal, *Professor of Nature Education, and Director of the Nature Guide School, Massachusetts State College.* Cloth. Pages xi+322. 15×23 cm. 1940. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $3.00.

"Cap'n Bill," the nation's greatest out-of-doors leader for youngsters of all ages, presents this pioneer text for guide leaders. He begins where nature education starts—in the home, where the child first learns about his pets and the garden flowers. The picnic, the family hike, and the summer camp are the early nature schools where parents have a great opportunity and real responsibility for teaching the fundamentals about some of life's great problems. The nature activities of the community including the work of the schools, clubs, scout troops, and the value of city parks make up the subject matter of chapter II. The summer camp comes next, with practical suggestions for camping, cooking, athletics, camp gardens, museums, and use of native materials. Chapter IV is a library on how to make nature trips interesting and useful. Whether it be the farmer's pigpen or the wonders of Going-to-the-Sun, Cap'n Bill tells how to make the most of it. Chapter V on conservation completes Part I. Part II might be called a laboratory manual for nature guiding. Camp equipment, cooking recipes, nature games, and the technique of leadership are among the many topics for practical treatment. It is a book for every home and school. No leader of a girls' or boys' club can afford to be without it.

G. W. W.

THE STORY OF SUPERFINISH, by Arthur M. Swigert, Jr., *Director of Production Research for Chrysler Division.* Cloth. 672 pages. 15×23 cm. 1940. Chrysler Corporation, Chrysler Sales Division, Detroit, Mich.

This is a book which discusses all the multitude of processes in producing the finish of metallic surfaces. The author has treated every aspect, described all procedures in detail, and explained all techniques involved. This includes examination of the characteristics of various metals and alloys, machining, grinding, boring, and polishing. The author's description of accurate measurement and scientific examination of surfaces with all the precision tools science and technology have been able to provide make the book interesting to the scientist and technician alike. The book is elaborately illustrated with over seven hundred halftones and diagrams.

G. W. W.

THE DEVELOPMENT OF MATHEMATICS, by E. T. Bell, *Professor of Mathematics, California Institute of Technology.* Cloth. Pages xiii+583. 16×23 cm. 1940. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Price $4.50.

According to the author, this book was written in response to many requests for a broad account of the general development of mathematics; not a history of the traditional kind. Very definitely it is not a traditional textbook, in fact it is somewhat doubtful that one would wish to use it as a text. The major emphasis is on mathematics beyond the calculus. Certainly much material mentioned would be new to many undergraduates.

Some faint idea of the content of the book may be obtained from consideration of representative chapter headings; Detour through India, Arabia, and Spain; Invariance; Uncertainties and Probabilities; Arithmetic Generalized; From Applications to Abstractions. A rather extensive collection of notes provides references for those seeking further information on special topics.

Unquestionably this volume should be in every college library. It should also be in the library of any student or teacher who is interested in some knowledge of the main directions along which living mathematics has developed.

CECIL B. READ
University of Wichita

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

Registration List, Fortieth Annual Convention
November 22, 1940, Cleveland, Ohio*

ILLINOIS

Batavia
Gutekunst, Hans

Belleville
Hexter, E. G.

Berwyn
Burns, E. E

Chicago
Adams, Forrest E.
Barr, D. L.
Beauchamp, Wilbur
Brooke, Clem
Frank, O. D.
Hewitt, Glenn F.
Isenbarger, Jerome

* It is regretted that incomplete registration makes it impossible to list the names of many teachers who attended this convention.

RAY C. SOLIDAY, *Secretary*

Isenbarger, Katherine U.
Jaglowski, Elizabeth A.
Johnson, J. T.
Kinney, J. M.
Kinsey, May H.
Kitzmiller, D. W.
Lawver, Mrs. J. L.
MacNeish, Agnes
Mayfield, John C.
McNamara, Donald M.
Oestreicher, Milton D.
Olson, Esther D.
Overn, Orlando E.
Peebles, Grace E.
Peterson, George E. O.
Sister Mary Evarista
Sister Mary Silva
Sister M. Vincenza Wynne
Stone, Charles A.
Tapley, Philip A.
Warner, Glen W.

Decatur
Kunze, Elmer
Nelson, T. A.

Evanston
Runge, Francis W.
Russell, David W.

Macomb
Schreiber, Edwin W.

Oak Park
Aeby, Ross
Johnson, Elsie Parker
Metcalf, Harold H.
Park, R. Emerson
Soliday, Ray C.

Urbana
Howd, M. Curtis
Tilbury, Glen

Waukegan
Barczewski, Walter
Frey, Franklin
Grosche, A. G.

Winnetka
Van Deursen, A. W.

Wood River
Oetting, Howard A.

Indiana

Indianapolis
Carnahan, Walter H.
Gingery, W. G.
Grant, Charlotte L.
Hanske, Carl F.
Johnson, Geraldine Reep
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Potzger, J. E.
Welchons, A. M.
Wilcox, Marie S.
Woline, R. W.

Lafayette
Troutman, L. H.

Muncie
Woodruff, Nathan H.

Richmond
Coulter, Kathryn E.

Rochester
Bushong, Mary

South Bend
Schubert, C. G.

Vincennes
Dunn, O. L.

Wabash
Black, R. D.

Iowa

Iowa City
Kambly, Paul E.
Pettit, Donald D.

Michigan

Ann Arbor
Matzke, H. W.
Quigley, Sidney M.

Detroit
Agren, Raymond
Barnhart, J. D.
Boyd, T. A.
Clark, Homer A.
Gaylord, Howard W
Hillebrand, Victor C.
Jennings, L. E.
Leonard, Clarence J.
Leonhard, Fred D.
MacVittie, Alexander
Massey, Emil L.
Wilson, Sherman R.
Woodbeck, Bernice M.

Owosso
Moore, Fred W.

Pontiac
Sweet, Arthur

Ypsilanti
Studt, Earl

Missouri

St. Louis
Long, Ernestine M. J.
Teeters, W. R.

New York

New York City
Powers, S. R.

OHIO

Akron
Caldwell, Sarah C.
Culp, Vernon S.
Danforth, Florence
Frye, Walter
Klein, Herman F.
Shriber, Clarence
Wagner, John A.
Williams, Terrence E.
Barnesville
Hunt, Dias E.
Berea
Stabler, E. R.
Bowling Green
Organ, Donald G.
Cambridge
McFarland, Cecil
Canton
Housley, Florence F.
Sister M. Constance
Sister M. Maurice
Chillicothe
Latshaw, Clark Clayton
Cincinnati
Lambert, Ray
Lampkin, Richard H., Jr.
Lyons, Harley K.
Oechsle, Bertha
Vordenberg, Kenneth E.
Cleveland
Adell, James C.
Arbuthnot, Ann
Armstrong, Helen J.
Baker, A. O.
Baker, Harold W.
Bemisderfer, F. R.
Bower, Ernest O.
Burgess, Anna E.
Bush, G. L.
Chapman, Mabel E.
Coburn, Helen R.
Couden, Eugenia C.
Cowan, M. J.
Crow, Glenn S.
Crow, Ralph, Jr.
Crumb, R. A.
Denton, Mary Lou
Eldred, A. N.
Fliedner, Frieda
Fowler, Katherine R.
Grime, Herschel
Henderson, Clyde A.
Henry, Nell C.
Hoffman, David L.
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Hunter, Mabel R.
Imhoff, G. C.
Jones, Franklin T.
Kraft, Ona
Lambert, George F.
Lawrence, William G.
Lowry, Florence
Manceni, Joseph
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Marshall, William M.
Melrose, Mary
Muthersbaugh, G. C.
Neal, Nathan A.
Peterson, Vincent R.
Ptacek, T. W.
Roy, Herman T.
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Runkle, R. C.
Schneider, L. R.
Sepeta, E. L.
Sisley, Ernest E.
Sister M. Celine
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Sister Regis
Sister M. Virginia
Smith, Villa B.
Smith, Walter N.
Sutter, Carleton A.
Thomas, Alma
Thomason, Anna L.
Van Horn, J. L.
Welton, Louis E.
Wielson, Glen
Wilson, S. O.
Cleveland Heights
Langmead, J. C.
McFadden, Merle G.
Columbus
Bell, John
Cahoon, G. P.
Davis, Abe
Jarvis, C. W.
McGregor, Rev. G. C.
Reichert, Charles V.
Stager, Paul B.
Wilner, G. J.
Copley
Miksch, R. A.
Cuyahoga Falls
Cox, N. W.
Schiefer, James W.
Cuyahoga Heights
Grove, Ewart L.

Delaware
 Wolff, W. G.
East Cleveland
 Vermillion, K. R.
Elyria
 Lautenschleger, Earl
Euclid
 Bickel, Mildred
 Gebhart, James W.
 Spangler, H. W.
 Stubbart, I. M.
Hudson
 Tallentin, John R.
Kent
 Herchek, Michel
 Shuster, C. N.
Lorain
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 Holder, R. J.
 McGill, Martin V.
Malta
 Porter, William O
New Lexington
 Matz, Walter
Norwalk
 Lawrence, G M.
 Sister M. Agnese
Oberlin
 Anders, Hanna K.
Oxford
 Christofferson, H. C.
Painesville
 Brown, Elijah H.
 Pollock, Layton C.
 Smith, D. R.
Parma
 Cassidy, Catherine
Sandusky
 Fleming, C. E.
Shelby
 Young, Charles D.
South Euclid
 Sister Mary Edith
 Sister Mary Joseph
Steubenville
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Tiffin
 Pinkerton, Robert
Toledo
 Gates, Florence
 Goodall, Josephine
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 Longbrake, Eleanor
 Severens, Frances H.
 Sister M. Camillus
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Uhrichsville
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Wadsworth
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 Streng, Arthur A.
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 Glass, H. D.
 Patterson, H. G.
Youngstown
 Hershberger, W. R.
 Lyman, Laura
 Sister M. Bernard
 Sister M. Lorita
 Sister M. Perpetua
 Sister M. Regina Schneider

TENNESSEE

Nashville
 Webb, Hanor A.

WISCONSIN

Beloit
 Rhodes, Joseph A.
Fond du Lac
 O'Neil, Ellen M.
Madison
 Davis, Ira
Milwaukee
 Roecker, W. F.
 Sister M. Mira
 Sister M. Mirabella
Racine
 Potter, Mary A.
Sheboygan
 Peterson, George K.
Superior
 Wilkins, R. C.
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 Roeske, Elmer A.
West Allis
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"It is the mind that makes the man and our vigor is in our immortal soul."

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